SEP 14 1981

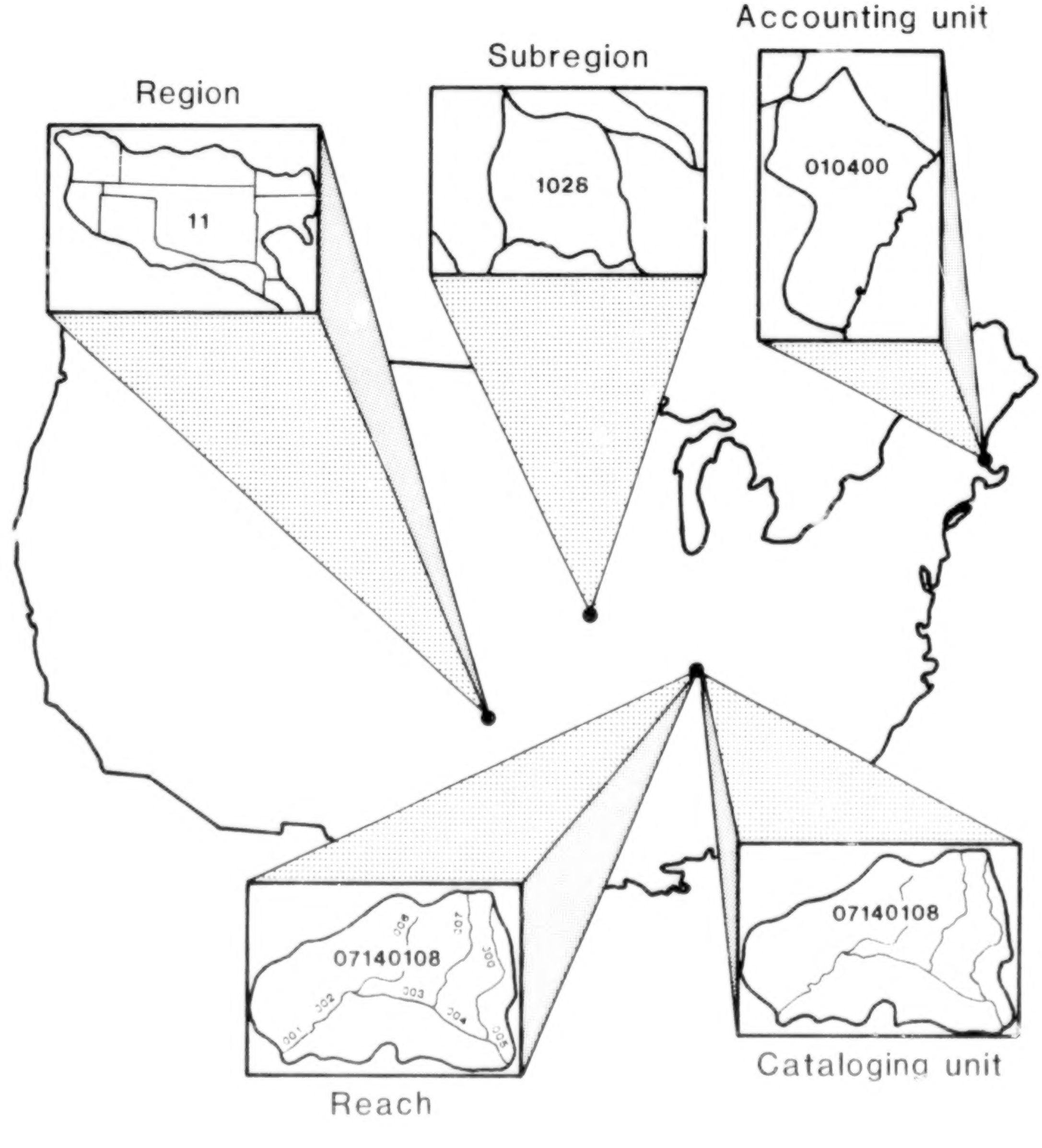
612

I 49.2:R52

Biological Services Program

FWS/OBS-81/31
SEPTEMBER 1981

RIVER REACH PHASE II REPORT: A Standardized Method for Classifying Status and Type of Fisheries



Fish and Wildlife Service
EPA

U.S. Department of the Interior

The Biological Services Program was established within the U.S. Fish and Wildlife Service to supply scientific information and methodologies on key environmental issues which have an impact on fish and wildlife resources and their supporting ecosystems. The mission of the Program is as follows:

1. To strengthen the Fish and Wildlife Service in its role as a primary source of information on natural fish and wildlife resources, particularly with respect to environmental impact assessment.

2. To gather, analyze, and present information that will aid decisionmakers in the identification and resolution of problems associated with major land and water use changes.

3. To provide better ecological information and evaluation for Department of the Interior development programs, [illegible] as those relating to energy development.

Information developed by the Biological Services Program is intended for use in the planning and decisionmaking process to prevent or minimize the impact of development on fish and wildlife. Biological Services research activities and technical assistance services are based on an analysis of the issues, the decisionmakers involved and their information needs, and an evaluation of the state-of-the-art to identify information gaps and determine priorities. This is a strategy to assure that the products produced and disseminated will be timely and useful.

Biological Services projects have been initiated in the following areas:

Coal extraction and conversion

Power plants

Geothermal, mineral, and oil shale development

Water resource analysis, including stream alterations and western water allocation

Coastal ecosystems and Outer Continental Shelf development

Systems and inventory, including National Wetlands Inventory, habitat classification and analysis, and information transfer

The Program consists of the Office of Biological Services in Washington, D.C., which is responsible for overall planning and management; National Teams which provide the Program's central scientific and technical expertise, and which arrange for contracting of Biological Services studies with States, universities, consulting firms, and others; Regional staff who provide a link to problems at the operating level; and staff at certain Fish and Wildlife Service research facilities who conduct inhouse research studies.

FWS/OBS-81/31
September 1981

REACH FILE PHASE II REPORT:
A Standardized Method for Classifying Status and Type of Fisheries

by

James E. Olson, Elizabeth A. Whippo, and Gerald C. Horak
Enviro Control, Incorporated
1520 East Mulberry Street
Fort Collins, Colorado 80524

Contract No. 14-16-0009-79-106,
Work Order No. 4

Project Officer

Lee S. Ischinger
Western Energy and Land Use Team
Creekside Building One, 2625 Redwing Road
Fort Collins, Colorado 80526

Performed for
Western Energy and Land Use Team
Office of Biological Services
Fish and Wildlife Service
U.S. Department of the Interior
Washington, D.C. 20240

Library of Congress Catalog Card #81-600103

CONTENTS

Page

FIGURES iv
TABLES v
ACKNOWLEDGEMENTS vi

INTRODUCTION 1
REVIEW OF LOTIC CLASSIFICATION LITERATURE 5
  Descriptive 5
  Evaluative 6
PROPOSED FISHERY STATEMENT 10
  Proposed Evaluative Section 12
    Criteria 12
    Criteria Scoring 17
    Confidence Rating 19
  Fishery Improvement Potential 21
  Proposed Descriptive Section 23

REFERENCES 32
GLOSSARY 39

APPENDICES

  A. Summary of Comments 41
  B. Abstracts of Pertinent Stream Classification Systems 50

FIGURES

Number Page

1 Geographical distribution of respondents 2

2 Categories of lotic classification literature 5

3 Summary of the Reach File Fishery Statement 11

4 Example of computer printout for evaluative portion of Fishery Statement--Ogeechee River near Eden, Georgia 22

TABLES

Number Page

1 Summary of criteria and probable information sources 13

2 Point scoring for the dominant sport fish species population 17

3 Point scoring for the sport fishery 18

4 Sport fishery classification by reach score category 19

5 Confidence rating scores and classification for a reach evaluation 20

6 Descriptors and probable sources of information 24

ACKNOWLEDGEMENTS

This is the Task 3 report for work order No. 4 under U. S. Fish and Wildlife Service Contract No. 14-16-0009-79-106, the final Reach File Phase II Report on a standardized method for classifying quality and type of fisheries. This study was funded by the U. S. Environmental Protection Agency's Monitoring and Data Support Division through an interagency agreement with the U. S. Fish and Wildlife Service's Office of Biological Services.

The effort covered by this report was contributed by James E. Olson and Elizabeth A. Whippo, assisted by Dr. Robert W. Pennak, Dr. Fred W. Rabe, Dr. Stuart G. Fisher, and Dr. Kenneth W. Cummins under the direction of Gerald C. Horak. Lee S. Ischinger of the Water Resources Analysis Project, Western Energy and Land Use Team, U. S. Fish and Wildlife Service and Robert C. Horn and Tim S. Stuart of the Monitoring and Data Support Division, U. S. Environmental Protection Agency, provided guidance and review.

The authors of this report wish to thank the technical review session participants and the agencies and individuals who reviewed earlier drafts of this report. Appendix A lists the participants and reviewers.

INTRODUCTION

This report represents the principal effort of Phase II of the U. S. Fish and Wildlife Service's (FWS) involvement with the development of the Reach File. The Reach File is a computerized catalog based on the hydrological features of the United States and is designed to organize and analyze water resources data. The project was initiated by the U. S. Environmental Protection Agency (EPA).

The objective of Phase II was to design a standardized statement classifying the type and quality of fisheries in reaches cataloged by the File. Fisheries type is determined in this document by the species present, relative fish abundance, habitat categorization, and other parameters. Reproductive capabilities and capacity, diversity of the fishery, and degree of contamination reflect quality in the proposed system. The system proposed in this document was independently reviewed by prospective users in the FWS, EPA, and other organizations. Their concerns were jointly reviewed at a technical review session which critiqued a draft version and solicited guidance for the preferred approach described in this document. (Appendix A gives a summary of the comments received; Figure 1 is a map of the geographical distribution of the respondents.)

The purpose of the Reach File is to provide interpreted information related to water quality, toxic substances, flows, fisheries, and aquatic life for over 60,000 stream reaches throughout the United States. The File also will cross-reference and facilitate access to extensive water data storage and retrieval systems such as EPA's STORET and the U. S. Geological Survey's (USGS) WATSTORE. The File will improve the ability of Federal, State, and local decisionmakers to retrieve water related information on a specific stream reach to assess existing and potential impacts or monitor the results of water pollution control or water resource development activities. Because it is national in scope and computerized, the Reach File will be capable of performing extensive assessments of existing conditions, trends, and program impacts concerning aquatic resources. These capabilities are a central focus of the File because of EPA's Congressional mandate to prepare overviews of the nation's water quality and the effects of EPA programs. The File input will be used to determine if the chemical, physical, and biological integrity of the nation's waters has been restored and maintained. This is an objective of PL 92-500, the Federal Water Pollution Control Act of 1972.

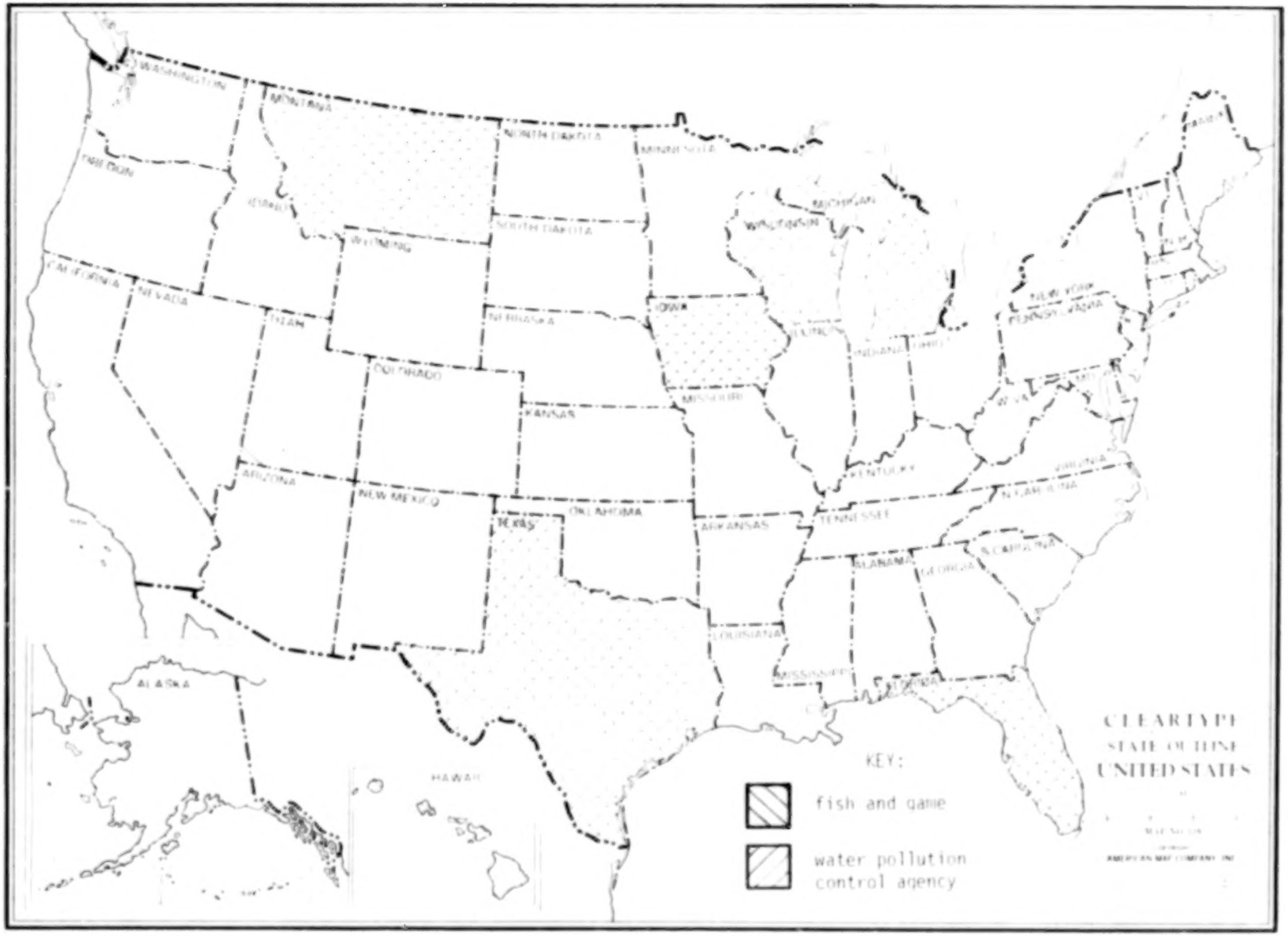


Figure 1. Geographical distribution of respondents.

The term "reach" as defined by EPA refers to that portion of a stream or river which extends downstream from the confluence of two streams or rivers (or from the uppermost end of a stream or river) to the next encountered confluence. Presently, streams and rivers, and their confluences, are those which can be traced from a map with a 1:500,000 scale. It is anticipated that in the future the File will be improved by using maps of greater resolution. In most instances in the File, a reach extends from one confluence to the next one downstream. Reaches are generally between 5 and 20 miles long; where a segment of river is too long between confluences and substantial changes in water quality are occurring, the segment can be broken down to several reaches as appropriate. Reaches end at the beginning of tidal influences and do not include reservoirs. Reaches are arranged within the accepted U. S. Department of the Interior hydrological cataloging system of hydrologic regions, subregions, accounting units, and cataloging units. These are shown on widely used, readily available USGS maps.

In Phase I, FWS provided EPA with a national overview of the type, quality, extent, and overlap of existing information on fisheries and aquatic habitat for a sample of stream reaches (U. S. Fish and Wildlife Service 1980b). The sample reaches were classified on the basis of two sets of maps: the 1978 "Stream Evaluation Maps" for 10 western states (U. S. Fish and Wildlife Service 1978a-j)[1] and the "Streams of National Significance for Fish and Wildlife" map (U. S. Water Resources Council 1977). Although a substantial amount of fisheries-related information relevant to the sample reaches was found in State, Federal, and private repositories, the classification scheme used for the study resulted in an inordinate number of reaches being classified as highest-valued or unclassified fishery resources. This problem was due to (1) a large number of reaches that were not evaluated on either set of maps; and (2) the use of criteria (i.e., the presence of anadromous fishery or endangered or threatened species) to determine a highest-valued fishery resource with no differentiation between current versus potential habitat. The problems encountered in Phase I were a major impetus in the design of Phase II activities.

The objectives of the Fishery Statement include the following: (1) be feasible to implement and practical to use; (2) have nationwide application with minimal variation from State-to-State; (3) rely predominantly on existing information (where possible); (4) produce a numeric index or descriptor; (5) have some intuitive meaning; and (6) be amenable to updating and revision. The overall goal of the File is to provide interpreted and synthesized information for the FWS, EPA, and perhaps others such as the National Marine Fisheries Service (NMFS), Soil Conservation Service (SCS), Council on Environmental Quality (CEQ), regional planning agencies, and various State agencies and private organizations. The Fishery Statement presents information at two levels, evaluative and descriptive. The evaluative information could be utilized by Federal headquarters and regional offices in developing national and regional assessments. For example, the FWS might review the system when determining important resource problems. Other uses of this type include annual reporting, trend analysis, Coastal Zone Management planning and 208 planning, and 305b report preparation under the Clean Water Act. On the other hand, the descriptive information will be more useful for site specific planning. State and Federal field offices will be more likely to use this information than higher administrative levels. For instance, FWS field office personnel might be able to utilize the descriptive information when reviewing and preparing responses to Sections 404 and 402 of the Clean Water Act and Section 10 permits of the River and Harbor Act of 3 March 1899. Other uses of the stored information include EIS review; monitoring of contaminants; surveillance of fisheries, including anadromous and commerical; industrial facilities siting, and endangered species protection.

---

[1] Two of these maps have subsequently been revised (U. S. Fish and Wildlife Service 1979, 1980c).

REVIEW OF LOTIC CLASSIFICATION LITERATURE

The system developed in this report has as its primary purpose the evaluation of the fisheries of lotic environments. With this purpose in mind, the lotic classification literature surveyed can be categorized as shown below in Figure 2.

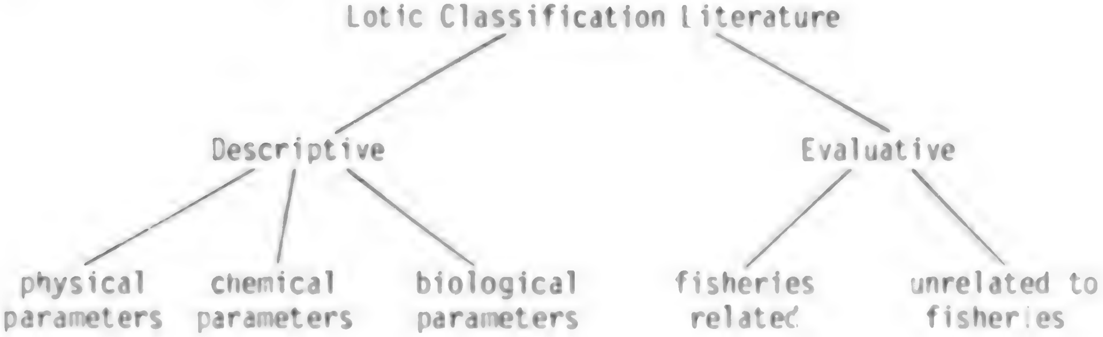


Figure 2. Categories of lotic classification literature.

DESCRIPTIVE

Many of the classification systems which have been developed have as their purpose describing the lotic ecosystem and grouping similar waters in order to gain insight into natural processes. These systems describe or group using a variety of parameters--physical, chemical, or biological. One of the early systems based on a physical parameter was that of stream order developed by Horton (1945) and later modified by Strahler (1957). In the modified version the smaller fingertip tributaries (usually restricted to those with a permanent flow) are designated Order 1; where two first order streams meet, a second order stream is formed; two Order 2 streams form an Order 3, and so forth. Cummins (1975) categorized streams into three groups based on stream orders (1-3, 4-6, and 7-12); a variety of characteristics were associated with each group. (See Appendix B for synopses of these and other classification systems.) Other systems primarily using physical parameters to describe the lotic system include Rabe and Savage (1977), Cowardin et al. (1979), Platts (1979a), and Terrell et al. (1980).

Systems have also been designed to describe the lotic environment using biological parameters. For example, several systems, mostly European, have been developed dividing the river into zones based on the typical fish species (for discussion see Illies and Botosaneanu 1963; Hynes 1970; Hawkes 1975). One such system designed for Maryland streams by Van Deusen (1953) divides the streams into 11 classes ranging from a "dace trickle" in the mountains to a "tidal stream" entering the ocean. Knight and Gaufin (1967) based their classification of streams on the longitudinal distribution of species of stoneflies. Still other systems employ a combination of physical, chemical, and biological parameters. Zhukinskiy et al. (1976) proposed a system in which extensive biological information is gathered along with a large amount of nonbiological data. This information includes data on biomass, number of species, total abundance, and primary production of the phytoplankton, phytomicrobenthos [sic], and macrophytes. Also, similar information on the macrozoobenthos and bacteria is included.

These systems were designed to describe (not evaluate) lotic environments, and were generally designed for unpolluted waters. Often such systems would not reflect perturbations caused by an influx of pollution (e.g., those based on order, gradient, substrate). EPA (1980) found that surrogate measures of biological integrity (i.e., physical or chemical analyses of the water column) often were inconsistent with biological data. Some systems also are to be used primarily for lower order streams or specialized areas of the country (e.g., Pennak 1971; Rabe and Savage 1977; Platts 1979a). Consequently, because most of these systems will not give a valid indication of the status of the fisheries and they are descriptive, they could not easily be modified to an evaluative system. These systems did, however, lend insight into important considerations in describing lotic ecosystems; hence many of those parameters considered important in determining habitat and affecting fish species have been included in the descriptive section of the Fishery Statement.

EVALUATIVE

Among those systems which result in a score to categorize the stream or river, two were found which evaluate using hydrologic factors (Pfankuch 1975; USDA Forest Service n.d.). These two systems, developed for use by the U.S. Forest Service, were designed to reflect changes in the hydrology and sediment stability. Pfankuch (1975) scored stream channels on 15 factors ranging from gradient to the percentage of scouring and deposition to determine channel erosion potential, resistance to streamflow forces, and capacity to adjust to and recover from changes in discharge or sediment production. Those streams receiving the lowest score were said to be most stable. The proposed classification of the Water System Corridor (USDA Forest Service n.d.) divided the aquatic zone into three major types and seven subtypes based on eight hydrologic factors. Scores were assigned to ranges for each factor, these numbers were then summed to determine the stream type and subtype classification.

The systems which proved most useful in devising the evaluative part of the Fishery Statement were those directly evaluating fisheries. All of the systems found evaluate primarily the sport fishery. The first such systems were developed and used by individual States. Four of the State classification systems identified and analyzed (Stream Classification Committee 1965; Idaho Fish and Game Department 1968; Bailey et al. 1974; Wyoming Game and Fish Commission 1977) were generally based on four factors. aesthetics, availability, use, and productivity. The system for Wyoming does not include use; the Idaho system includes stream size in addition to the other four factors. The highest rating that can be obtained is for high trout production waters of nationwide importance.

Though these systems evaluate fishery resources, a bias exists towards the value of a salmonid fishery over any other sport fish species. The optimum rating is given to trout production streams which would not be applicable on a nationwide basis. Other than Idaho Fish and Game Department (1968) these systems do not take into account the value of a stream reach due to the presence of excellent spawning habitat, anadromous species, or threatened and endangered species. There also is an emphasis on socioeconomic values (aesthetics, use, and accessibility). Although socioeconomic factors are not ignored in the proposed system, the purpose of the Fishery Statement is to evaluate the biotic component of the fishery resource value. However, these maps did promote the concept of rating streams with set criteria on the basis of the sport fishery.

The system designed by Michigan (Anonymous 1967) divides streams into type and quality as follows:

- Trout stream
  - top quality
    - mainstream
    - feeder stream
  - second quality
    - mainstream
    - feeder stream

- Warmwater stream
  - top quality
    - mainstream
    - feeder stream
  - second quality
    - mainstream
    - feeder stream

These designations are based on stream size, ease with which the stream can be fished, and fish populations. Streams or rivers with significant populations of anadromous fish are designated. Consideration is also given to the fluctuation of stream subclasses, stream zone development, and impoundments. Though this system could be used for both warmwater and coldwater fisheries, there is an emphasis on recreational fishing.

An attempt to determine the streams of national significance for fish and wildlife was depicted in a map developed by the U.S. Water Resources Council (1977). Streams were coded using seven criteria: (1) nationally important sport fishery--drawing significant numbers of nonresident fishermen; (2) producing an anadromous fish resource which provides a fishery significant to the nation for its commercial and sport values in the sea; (3) producing a nationally important commercial fishery in inland streams; (4) supporting endangered or threatened species protected by the Federal Endangered Species Act, 1973, and five species proposed for endangered status; (5) enacted Federal Wild and Scenic Rivers; (6) officially proposed Federal Wild and Scenic Rivers; and (7) riverine habitat within the National Wildlife Refuge Systems.

The first criterion, rating a stream on the basis of the number of nonresident fishermen, is a function of stream accessibility and reputation, not necessarily a function of the fishery resource. Many streams were found to change status at State borders, and some States had few or no streams designated. The second and fourth criteria were evaluated on a macroscale. Thus, large areas of the map, especially coastal areas, were coded for these criteria even though existing local stream conditions may not warrant the coding. Also, the map does not distinguish between unmarked streams which were not found to be nationally significant and streams which simply were not evaluated. The map did, however, establish the concept of evaluating streams on a nationwide basis for a number of criteria and displaying the result for each criterion.

A series of Stream Evaluation Maps have been published by the U. S. Fish and Wildlife Service (U. S. Fish and Wildlife Service 1978a-j, 1979, 1980c) which evaluate streams in 10 western states. Permanent streams, their tributaries, those streams protected by or proposed for protection under the Wild and Scenic Rivers Act, and those intermittent streams considered necessary for the sustenance of a highly valued fishery were evaluated. Streams were placed into one of four value classes[2] (Class I — Class IV). Class I was a highest valued fishery resource while Class IV was a limited fishery. The criteria used to classify were (1) occurrence of State or Federal endangered species; (2) occurrence of State or Federal threatened species; (3) species of high interest to the State; and (4) habitat restoration, reclamation, or mitigation potential.

For each criterion, subcriteria were specified for each value class. Thus, each stream reach was assigned a value class for each criterion. The final value classification assigned to the stream reach was determined by the highest rating given in Criteria 1 through 3. Criterion 4 was used only in a few instances to adjust the overall evaluations. The Stream Evaluation Maps provided one overall classification for each stream rated, introduced the concept of fishery improvement potential as an adjustment rating criterion, and rated all permanent and many intermittent streams.

Users of the Stream Evaluation Maps were surveyed for their comments and criticisms; Short (1981) gives the results. The most common recommendation concerning the information in the map legend was to include the criteria used to rate each stream reach so that the user would know how each reach scored for each criterion. Another recommendation was to indicate whether streams not included in any value class had been rated or not. Respondents also suggested that more specific information be included in the legend on threatened and endangered species such as which species exist where and whether or not the habitat is critical habitat. Also, both plant and animal threatened and endangered species should be indicated. Some respondents recommended that criteria for threatened and endangered species not be combined with fisheries criteria. As occurred in the map of the U. S. Water Resources Council, streams changed classes at State borders although the streams themselves were unchanged.

---

[2] The Utah map included Class V--unsurveyed stream reach.

PROPOSED FISHERY STATEMENT

As previously stated, the Reach File is a catalog of hydrological features of the United States. To classify reach fisheries with regards to the type and quality of its biological components, a system is proposed in the following paragraphs which organizes and maintains a Fishery Statement for each cataloged reach. The system does not attempt to address the value of a reach fishery resulting from recreational or other uses; rather, it attempts to classify the biological importance of a reach based on the fish species present and their relative productivity.

The Fishery Statement is composed of two major divisions: (1) an evaluative section with ranking criteria for the sport fishery and other fishery considerations such as the presence of anadromous fish, commercially harvested fish, threatened and endangered fish species, and fish species of special concern; and (2) a descriptor section containing additional information specific to the evaluative criteria and data for biological, chemical, and physical descriptors of the reach. Figure 3 is an overview of the components of the Fishery Statement.

It is intended that this system be flexible so that users can retrieve those parts of the statement in which they are interested. For example, information on all reaches of a given stream order can be retrieved or only reaches in a certain geographical area. Also, reaches may be recalled that are listed as meeting a particular criterion of interest to the user. In this way, greater amounts of information about each reach can be stored without necessitating each user to sort through the entire data base.

The Fishery Statement is presented here in the conceptual phase; it has not been tested on a wide scale. Detailed testing will be performed in the next stage of Phase II. Without extensive testing, it is difficult at this point to determine the sensitivity or equitability of the system. Testing should elucidate whether or not the system can determine trends in a given reach and reflect accurate comparisons among reaches. Additional fine-tuning and modification are anticipated before the Fishery Statement becomes a full-scale component of the Reach File.

To evaluate the type and quality of reach fisheries various options are evident: all fish species can be evaluated or various subsets thereof. Though the best option from a biological viewpoint is to use all fish species, consideration of this option is precluded by the availability of

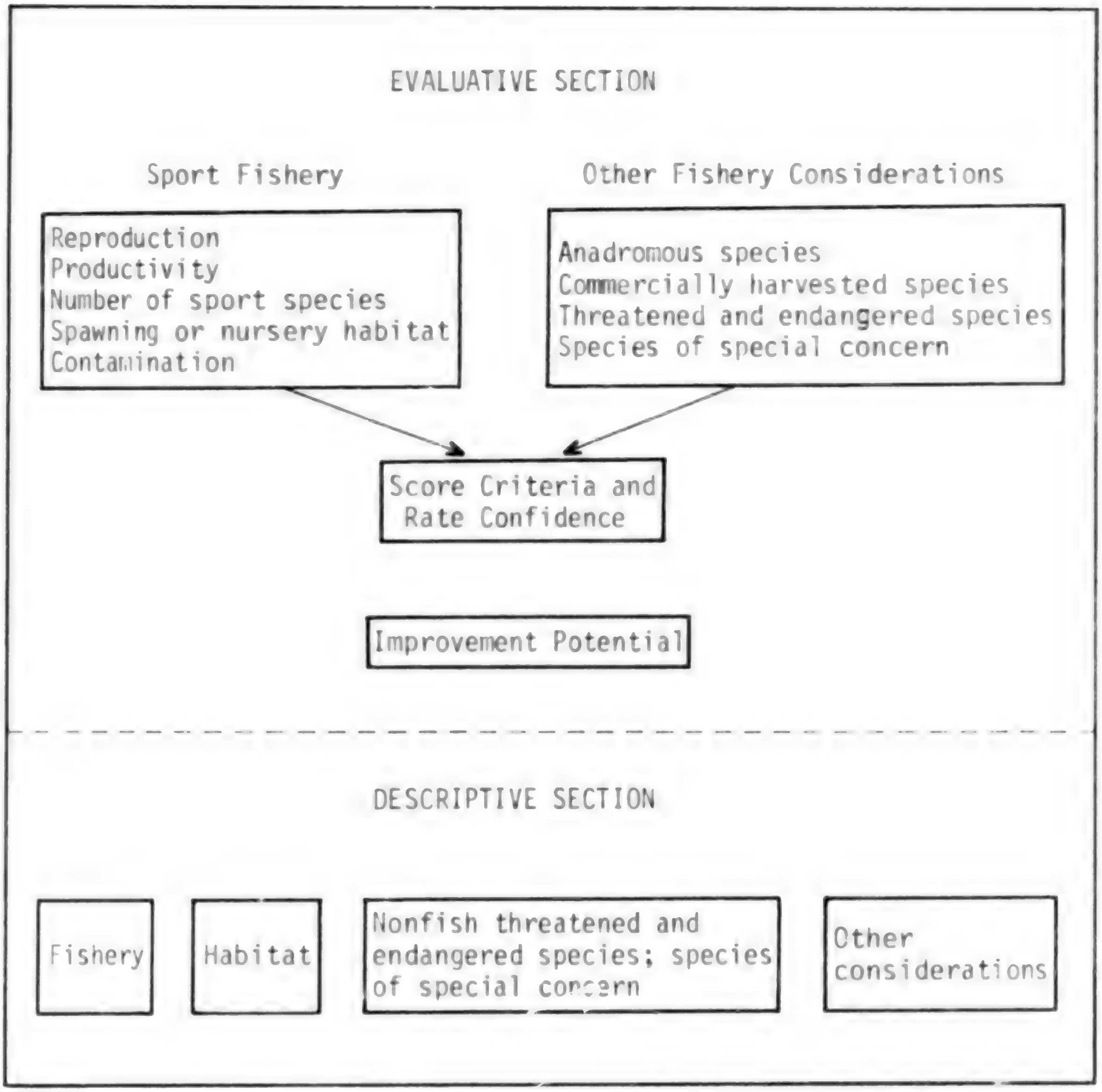

EVALUATIVE SECTION
Sport Fishery
Other Fishery Considerations
Reproduction
Productivity
Number of sport species
Spawning or nursery habitat
Contamination
Anadromous species
Commercially harvested species
Threatened and endangered species
Species of special concern
Score Criteria and Rate Confidence
Improvement Potential
DESCRIPTIVE SECTION
Fishery
Habitat
Nonfish threatened and endangered species; species of special concern
Other considerations

Figure 3. Summary of the Reach File Fishery Statement.

data. Most fishery studies focus on species of interest to scientists, managers, and the general public; therefore, the greatest amount of data are collected on sport fish, anadromous fish, commercial fish, threatened and endangered fish, and various species or collections of species of particular concern for preservation and management. The evaluative scheme as presented requires a certain amount of subjectivity on the part of the biologist who will rate individual reach fisheries. Forcing decisions about segments of the fishery that are seldom studied and poorly known adds greatly to the biases and inaccuracies of the system. Consequently, though other species add to the value of the fishery and influence its quality, the focus of the Fishery Statement is on sport fish, anadromous fish, commercial fish, threatened and endangered fish, and fish species of special concern.

In evaluating a reach fishery, the existence of any of the above-mentioned types of fish may determine an important fishery; a combination of several types is not really necessary. Additionally, where a fishery is made up of more than one of these important types, equitable assessment on a broad scale becomes more difficult. It is not feasible to differentiate the increasing degrees of importance of a multi-component fishery because of the incomparability of these various fishery types. As a result, the evaluative section of the Fishery Statement will be designed to assess each component of a fishery (sport, anadromous, commercial, threatened and endangered, special concern) separately. An evaluation of the resident sport fishery will be made in all cases; the reach will then be appraised for its importance on the basis of the "other considerations." A reach may have a low-rated sport fishery but be considered important because of the seasonal presence of anadromous fish, for instance. The Reach File will maintain separate stores of information for conditions which led to the reach evaluation and a mapping scheme will be devised so that all of the assessment results can be displayed graphically. No attempt will be made, however, to categorically state the relative value of the important components of a reach fishery. Information on each of them will be available to a system user so that a different evaluation based on a single component or particular combination is possible.

PROPOSED EVALUATIVE SECTION

Criteria

The evaluative section is divided into two categories concerning the sport fishery and other fishery considerations of a reach. Criteria for the sport fishery deal with reproduction, productivity, number of sport species, spawning or nursery habitat, and contamination. Other fishery considerations concern the actual presence or habitat of anadromous fish, threatened and endangered fish, and fish species of special concern. Table 1 is a summary of the criteria and their probable sources of information. Most of these criteria have been proposed and used in some form in other aquatic classification systems, particularly those of the Stream Classification Committee (1965), Idaho Fish and Game Department (1968), Bailey et al. (1974), U. S. Water Resources Council (1977), Wyoming Game and Fish

Commission (1977), and the U. S. Fish and Wildlife Service (1978a-j, 1979, 1980c).

For purposes of this system, a sport fish is defined as any fish species for which a state has set a legal bag limit for a conventional fishing license. Each state will use its own fishing regulations to compile a list of sport fish species for evaluation of reaches within its jurisdiction. The sport fishery criterion is based on the fish population inhabiting the reach, the management efforts associated with it, and its relative productivity. The initial evaluation concerns only the most dominant sport fish species though later consideration is given to additional sport fish. Dominance is assessed on the basis of biomass, as opposed to numbers or other indicators of dominance. This is because of the generally greater reliability of the biomass indicator for organisms such as fish with relatively similar size-metabolism relationships (Odum 1971). The assessment of dominance will often require an estimate by the biologist doing the rating though an error in this estimate is not likely to have drastic impacts on the remainder of the evaluation.

Table 1. Summary of criteria and probable information sources.

Criterion	Probable source of information
Sport Fishery	State fish and game agencies
Other Fishery Considerations	
Anadromous fishery	State fish and game agencies; NMFS
Commercial fishery	State fish and game agencies
Endangered and threatened species	U. S. Fish and Wildlife Service, Office of Endangered Species
Species of special concern	State fish and game agencies

The dominant sport fish populations are assigned to one of the following categories.

- mostly self-sustaining population;
- hatchery supported population, infrequently stocked; and
- hatchery supported population, frequently stocked.

Self-sustaining populations are those which will maintain a sport fishery resource with basic enforcement of fishing regulations and habitat protection. Hatchery supported populations are infrequently stocked if stocking occurs less often than once annually; frequently stocked populations receive support on an annual basis or more often.

Obviously, fishery science includes techniques for assessing fish populations which are more critical and informative than the simple classification shown above. For instance, population estimates from depletion sampling or mark and recapture methods have been used for some time. However, the Fishery Statement is limited, at this stage of the Reach File development to using existing data. While population estimates of various types are available for many stream segments, the Fishery Statement must be designed for nationwide application to reaches where such estimates have not been made.

The dominant sport fish population is further evaluated according to its productivity. The productivity of the dominant species should reflect the overall productivity of the entire sport fishery because the energy flow within the group is largely controlled by the dominant species (Odum 1971). Regardless, the error implicit in this assumption is minimized by the additional consideration given to fisheries with other sport species besides the dominants. Also, the assessment is fairly cursory requiring classification of productivity only as high, moderate, or low which allows for some interpretation and modification by the rating biologist. Again, fishery science has other, more critical methods for assessing fish productivity but information availability for the range of reaches preclude their use in the present system.

One of the difficulties in the productivity assessment is establishing a standard for comparison for the reach in question. Without a comparison, a productivity declaration for a single reach is meaningless because the range of an absolute value such as pounds produced per acre of stream surface area has not been determined for the wide variety of ecological factors affecting reach fisheries. A possible alternative is to compare the productivity of the existing reach to supposed pristine conditions, those occurring before man's presence and subsequent influence. The obvious problem is that pristine conditions are unknown quantities (National Commission on Water Quality 1976). It is difficult or impossible to predict what fish productivity may have occurred before man's presence; some populations may in fact have been less productive than those presently existing. This uncertainty would produce a meaningless comparison.

Another alternative is to compare the sport fish productivity of the reach to a supposed ultimate, "best case" situation. Given unlimited resources, a reach obviously could be improved to be more productive. However, the probable extent of the improvement actions and the productivity to be expected are difficult quantities to estimate. The feasibility and practicality of the modifications required to establish an "ultimate fishery" must be taken into consideration to produce a reasonable standard for comparison. Since the probability of implementation and the expected outcome of possible modifications are uncertain, the comparison becomes highly subjective and consequently unsuitable.

The next alternative is the most feasible of those mentioned for implementation within this system as it is currently designed. Productivity of the dominant sport fish in the reach in question will be compared to a regional standard, selected by the rating biologist, which has the supposed highest productivity of the same dominant species within the region. Because of the need for similarity among the compared reaches, it is recommended that the regions be confined to the 222 subregions as described by the U. S. Water Resources Council (1979). Further, the compared reaches should be of the same stream order or at least within the same groupings proposed by Cummins (1975); i.e., orders one through three, four through six, and seven through twelve. Assessment of productivity will be, as stated, in three categories, high, moderate, or low as compared to the regional standard. This assessment is obviously subjective and will not report as much information about the reach as may be desired. However, the productivity of a sport fishery is a strong determinant of its quality and the assessment may be improved by future data collection.

Additional factors for evaluating the sport fishery include the number of sport species inhabiting the reach and the use of the reach as spawning or nursery habitat by seasonally present sport species. The rating biologist will be asked to supply a list of all sport species considered residents of the reach. Seasonally present sport species do not include anadromous fish which are covered in a later category but rather those sport fish which migrate, for instance, from reservoirs up into flowing streams to spawn. Reaches used in this fashion are essential to the sustenance of these species and consequently receive greater consideration.

Another evaluation factor deals with contamination of sport fish from the reach. Though fish may be present in sufficient quantities to support a sport fishery, pollutants such as heavy metals (e.g., mercury, cadmium) or pesticides (e.g., mirex, DDT) may limit or prevent consumption of the fish from these waters. Contamination may be such that a government agency recommends no human consumption of fish from the reach, or the agency may recommend human consumption on a limited basis (a certain number of pounds of fish per month or meals per week as recommended maxima). For example, the New York State Department of Health recommends that individuals eat no more than one meal (1/2 pound) per week of fish from any water in the State (New York State Department of Environmental Conservation 1979). Also it is possible that, while contamination of the fish is not at a critical level, the flesh may be tainted to the extent that only limited consumption is occurring even though no official limitations have been recommended. This occurrence also deserves consideration.

The second category of the evaluative section includes other considerations important in assessing the value of a reach fishery. The first criterion in this category concerns anadromous fish species such as Atlantic salmon (*Salmo salar*), steelhead trout (*Salmo gairdneri*), chinook salmon (*Oncorynchus tshawytscha*), and coho salmon (*Oncorhynchus kisutch*). These resources are extremely important because of the valuable commercial and subsistence fisheries they provide in several areas of the country. Despite the fact that some of the species are also sport fish, this criterion is kept separate from the sport fishery evaluation because of their intrinsic value. Reaches directly connected to the Great Lakes and supporting spawning runs of species such as steelhead and coho salmon will be considered anadromous fisheries for the purpose of this system.

The next criterion under other considerations involves commercial fisheries. Commercial fish harvesting in a river indicates that productivity is great enough to support such an effort; with low productivity commercial fishing is not likely to be economically feasible. Conversely, the lack of commercial fishing may not indicate low productivity because other factors such as access and market availability greatly influence this enterprise. However, for those reaches where commercial harvesting is occurring, their fisheries should be rated accordingly.

Also under other fishery considerations is a criterion dealing with threatened and endangered fish species. These species have been designated by the government as being important and a commitment has been made by the nation to attempt to preserve those animals which have received such a designation. Although the importance of preserving threatened and endangered species is self-evident to many people, there have been a variety of justifications proposed for conservation. Ehrenfeld (1976) cites the following as examples of the values of "non-resources" which have been proposed:

- recreational and aesthetic;
- undiscovered or undeveloped;
- ecosystem stabilization;
- examples of survival;
- environmental baseline and monitoring;
- scientific research;
- habitat reconstruction;
- conservative value (avoidance of irreversible change); and
- conviction that animals have a right to exist and be left alone, or at least not be persecuted or made extinct.

To evaluate this criterion, the existence of critical habitat and present range of threatened or endangered fish species will be used.

The last criterion for other considerations covers fish species or assemblages of species considered to be of special concern to the State within whose jurisdiction the reach occurs. Fish species of special concern include State-listed threatened or endangered species; fish that are native to the State, region, or reach receiving special management attention for preservation; and species or assemblages of species that are of special concern for study and management. This criterion does not include Federally-listed endangered or threatened fish nor species receiving special management strictly to improve recreational fishing. This criterion also will be evaluated on the existence of habitat within the reach critical to the maintenance of the fish species involved.

Criteria Scoring

The following is a proposed method for weighing and scoring the previously described criteria. As stated earlier, however, the system has not been extensively tested and modifications are anticipated before full-scale application. Only the sport fishery criteria are given a range of scores that are summed to determine an overall score. Each of the other considerations receives a yes-or-no response; if the response is yes, the reach is rated as an important fishery resource. The Reach File will maintain a listing of the responses to each of the criteria so that a user can determine the reason a reach is rated as important rather than simply reporting the reach classification.

The initial scoring of the sport fishery is shown in Table 2. The points ascribed to each of these sport fish categories are fairly arbitrary but are loosely based on the relative quality of each of the fishery types. Note that only the dominant sport fish species is assessed initially.

Table 2. Point scoring for the dominant sport fish species population.

Productivity	Dominant population		
	Mostly self-sustaining	Hatchery supported, infrequently stocked	Hatchery supported, frequently stocked
High	16	14	12
Moderate	12	10	[illegible]
Low	8	6	4

A summary of the point scoring for the entire sport fishery is in Table 3. As shown in the table, if two or three additional sport fish species occur in the reach, one extra point is added; if four or more additional sport fish species occur in the reach, two points are added. This addition of points takes into account that few single species populations occur in streams and rivers and that the total productivity of the reach is often reflected in growth by several species. Also note in Table 3 that if sport fish exist in a reach but extremely low numbers or growth make the resource essentially insignificant by comparison to the total fishery, the score is one point. This score cannot be added to by extra points ascribed to the presence of additional sport fish species.

If the reach is used as spawning or nursery habitat by seasonally present sport fish species other than anadromous fish, one extra point is

Table 3. Point scoring for the sport fishery.

Factor	Score
Mostly self-sustaining population:	
high relative production	16
moderate relative production	12
low relative production	8
Infrequently hatchery supported population:	
high relative production	14
moderate relative production	10
low relative production	6
Frequently hatchery supported population:	
high relative production	12
moderate relative production	8
low relative production	4
Insignificant sport fishery[a]	1
Two or three additional sport fish species	1
Four or more additional sport fish species	2
Spawning or nursery habitat for seasonally present species	1
No fish contamination or tainting, or information unknown	0
Flesh tainted, consumption limited	-1
Contamination present, limited consumption recommended	-2
Contamination present, no consumption recommended	-3
Maximum Total	19

[a] Does not score for additional sport fish species.

added. If the sport fish are contaminated and no human consumption is recommended, three points are subtracted from the score. If contamination is occurring and limited consumption is recommended, two points are subtracted. If fish flesh is tainted and consumption is thereby limited, one point is subtracted. If no contamination or tainting is occurring or the information is unknown, the sport fishery score is not adjusted.

Responses to each of the sport fishery criteria are determined individually; the points attributed to the responses are totalled to produce an overall rating for the sport fishery of the reach. Table 4 depicts the sport fishery classification for each of the scoring categories.

Table 4. Sport fishery classification by reach score category.

Reach score	Sport fishery classification
14 - 19	Outstanding
10 - 13	Good
6 - 9	Fair
2 - 5	Poor
-2 - 1	Very poor

As stated previously, if there is a positive response concerning the presence of anadromous fish, commercial fish, threatened and endangered fish species, or fish species of special concern (or their critical habitats), the fishery resource classification is immediately 'Important'. No attempt is made to break down these criteria as was done for the sport fishery because the mere existence of this type of fishery resource makes a reach important. The Reach File will maintain separate stores of information for the responses to each criterion that led to a particular classification. For instance, the File will list the score and classification for the sport fishery and, if the reach is important under the other considerations, the criteria and responses will be displayed. In this manner, a system user will always be aware of the individual components of the reach fishery that produced the classification.

Confidence Rating

Along with the classification of the fishery resource, a confidence rating is determined to aid the system user in assessing the degree of reliance to place in the evaluation. The confidence rating is actually done at each step in the classification procedure. As responses to the criteria are determined, a numerical assessment of the relative confidence in the information used for the score determination is assigned. Confidence ratings are based on the following:

- quantitative documentation--scores four points;
- qualitative documentation--scores three points; and
- undocumented, professional opinion;
  --where professional is familiar with the reach--scores two points
  --where professional is familiar only with the general area--
  scores one point.

Quantitative documentation requires accessible, numerical data from fishery surveys conducted in the reach. Quantitative data include species presence and abundance, population and productivity estimates, biomass estimates, nest or redd counts, contamination levels, and river miles designated as critical habitat or present range of important species. Qualitative documentation indicates that interpreted information devices were used to determine responses to the criteria. Qualitative documentation includes maps or descriptive reports of the reach or area in general. If the interpretive reports were prepared from numerical data which is still available, the confidence rating is quantitative. Undocumented, professional opinion means that professionals familiar with the reach or area in question completed the assessment on the basis of their expertise. Professionals familiar with the reach must have been involved in sampling or interpretation of sample data from the reach. Professionals familiar with the area have not directly sampled the reach but their management jurisdiction includes the reach.

A confidence rating for a reach is calculated separately from the reach evaluation. The confidence ratings are summed for each criterion, then divided by the number of criteria to determine an average confidence rating for the reach information (Table 5).

Table 5. Confidence rating scores and classification for a reach evaluation.

Score	Rating
3.1-4.0	High confidence
2.1-3.0	Medium confidence
1.0-2.0	Low confidence

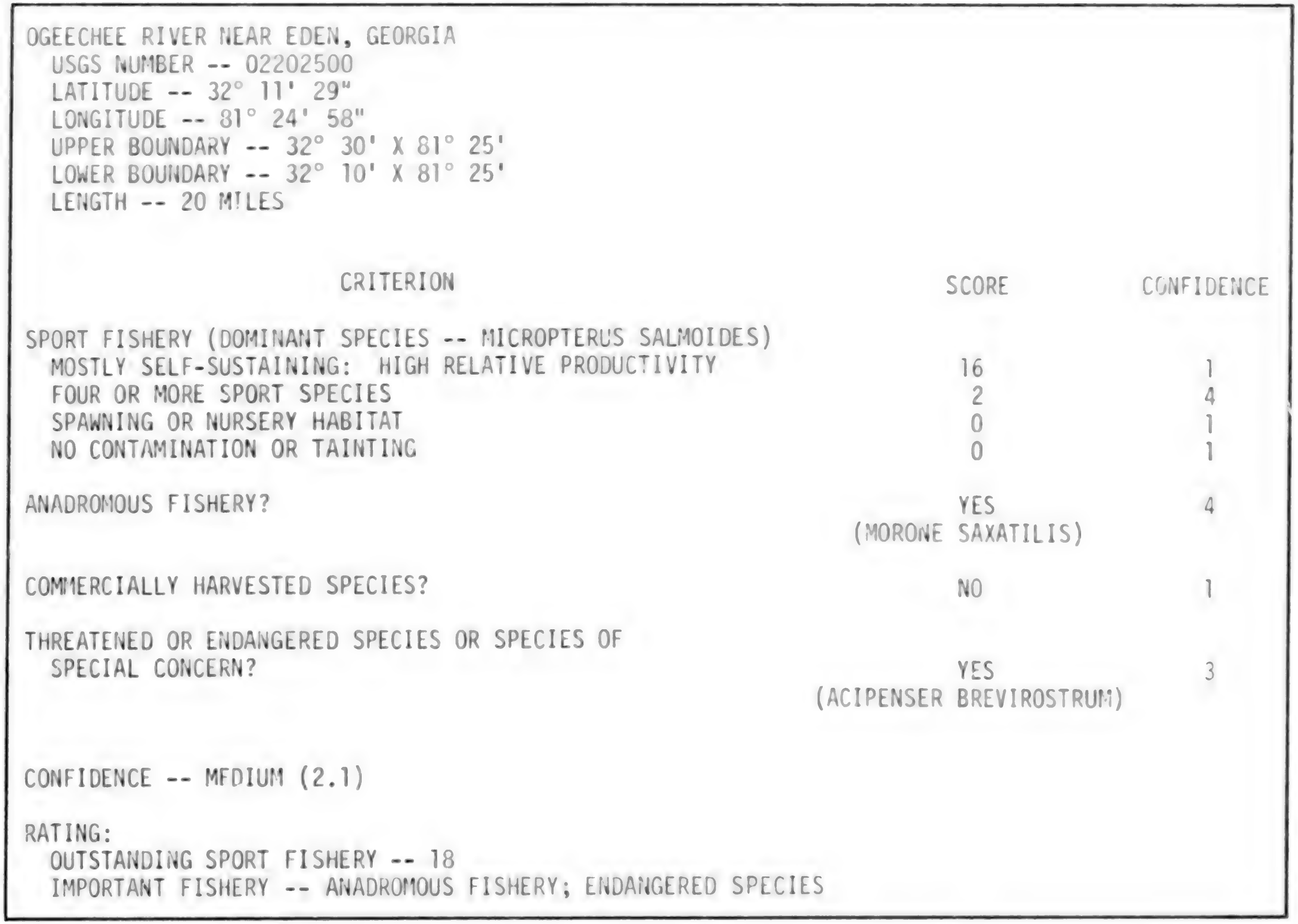
Some of the criteria will have generally lower confidence ratings than others, e.g., the assessment of reach productivity. However, this rating may be increased in States with stream classification systems that evaluate fish productivity or that collect productivity data. Other criteria will have higher confidence ratings, e.g., endangered species habitat which is usually designated by State or Federal authorities. The individual confidence ratings for each criterion, and the average, will be retained by the Reach File. Figure 4 depicts a sample calculation of a reach evaluation and confidence rating for the Ogeechee River near Eden, Georgia.

FISHERY IMPROVEMENT POTENTIAL

After a reach is evaluated for existing conditions, an assessment of the potential for improving the fishery may be desirable. This assessment would attempt to indicate how close a reach is to producing its "best possible" fishery and what constraints are currently limiting the fishery. The obvious difficulty in the assessment is determining what the "best possible" fishery is and establishing a workable standard for comparison. A similar problem was discussed earlier in setting a standard for comparison in productivity assessments. The solution proposed for the earlier problem, to use a regional standard reach, also will be used here. The same standard reach utilized for the productivity assessment will be evaluated under each of the criteria presented in the Evaluative Section for the sport fishery. The sport fishery score of the standard reach will be compared to the scores of all reaches of similar stream order in the subregion to infer improvement potential.

One of the shortcomings of this assessment is that the absolute improvement potential of the reaches may not be reflected by the comparison if the standard reach is not at or near its greatest potential. In response, the rating biologist will be asked for a subjective assessment of the improvement potential of the regional standard reach. This assessment will be based on the sport fishery criteria (i.e., could sport fish productivity be increased from moderate to high) given that basic land use patterns will not be changed and major alterations of aquatic habitat such as large dams will not be removed to improve the reach fishery. The biologist's assessment will be used to modify, where necessary, the numeric score of the regional standard.

Scoring for the improvement potential could be as a percentage of the regional standard or the total point spread from the regional standard. Regardless of the form, the improvement potential score should be maintained and reported separately from the existing conditions score. In this manner, a system user can independently generate both pieces of information. In addition, the rating biologist will be asked to identify, where possible, the probable causes or limiting factors of a reach fishery. Various categories such as point source pollutant, non-point source pollutant, physical barrier, lack of cover, and overuse will be suggested for selection. Limiting factors will cover the sport fishery and other fishery considerations as well. With this information, a system user can discern where the improvement potentials are greatest and what problems may be most solvable.



```
OGEECHEE RIVER NEAR EDEN, GEORGIA
  USGS NUMBER -- 02202500
  LATITUDE -- 32° 11' 29"
  LONGITUDE -- 81° 24' 58"
  UPPER BOUNDARY -- 32° 30' X 81° 25'
  LOWER BOUNDARY -- 32° 10' X 81° 25'
  LENGTH -- 20 MILES


                         CRITERION                                          SCORE       CONFIDENCE

SPORT FISHERY (DOMINANT SPECIES -- MICROPTERUS SALMOIDES)
  MOSTLY SELF-SUSTAINING:  HIGH RELATIVE PRODUCTIVITY                         16             1
  FOUR OR MORE SPORT SPECIES                                                   2             4
  SPAWNING OR NURSERY HABITAT                                                  0             1
  NO CONTAMINATION OR TAINTING                                                 0             1

ANADROMOUS FISHERY?                                                           YES            4
                                                                    (MORONE SAXATILIS)

COMMERCIALLY HARVESTED SPECIES?                                               NO             1

THREATENED OR ENDANGERED SPECIES OR SPECIES OF
  SPECIAL CONCERN?                                                            YES            3
                                                                 (ACIPENSER BREVIROSTRUM)


CONFIDENCE -- MEDIUM (2.1)

RATING:
  OUTSTANDING SPORT FISHERY -- 18
  IMPORTANT FISHERY -- ANADROMOUS FISHERY; ENDANGERED SPECIES
```

Figure 4. Example of computer printout for evaluative portion of Fishery Statement--Ogeechee River near Eden, Georgia.

PROPOSED DESCRIPTIVE SECTION

A descriptor section is provided along with the evaluative part of the Statement. The objectives of this section are (1) to provide and identify the data upon which the reach was ranked; and (2) to provide additional information about the river reach. The descriptor section will give an idea of the basis of the rating received by a particular river reach. When the status of a river reach changes these changes also will be reflected in the descriptors in addition to the overall score from the evaluative section.

It is recognized that this descriptor section is not all-inclusive; there are other descriptors which could be included. This section was designed to be flexible and descriptors can be added, changed or deleted as needed. These data will not be available for all reaches; however, for those reaches which have these data available, a place has been provided in the descriptor section. As additional data become available they can be included. In some circumstances, STORET, which is given as the probable source of data, will not have information. Data may then be obtained from other sources such as State fish and game agencies, EPA, FWS, or publications by a variety of organizations. Cross-references to other raw data bases such as U. S. Geological Survey's WATSTORE will also be provided.

The intention is not to facilitate the use of only existing descriptors before making major decisions about the fate of the reach. Users should remember that the usefulness of these data is only as good as the data themselves. Most of the descriptors included are highly variable over time and with sampling technique. Different techniques undoubtedly will be used; accuracy and precision will differ. In several instances an average of the parameter will be given, although obviously organisms do not experience averages. Because of these factors, the descriptors, for the most part, must be interpreted and will only indicate the conditions of the stream or river. Many of the descriptors are interrelated and hence should be analyzed together.

Table 6 is a list of the descriptors to be included and probable information sources. Because data availability will vary among reaches, the number of samples used to obtain averages and the range of values should be given, wherever possible.

Many States have their own system to classify or evaluate their fisheries; several of these were discussed earlier in this report. The information given should include both the numerical evaluation (if listed) and a verbal interpretation.

As a general descriptor of the fishery one of the following categories will be chosen for the reach: warmwater fishery, coolwater fishery, or coldwater fishery. These descriptors will immediately convey information to a fisheries biologist about the reach with regards to the temperature regime, possible fish species present, and other factors.

Table 6. Descriptors and probable sources of information.

Descriptor	Source of information
State classification	State agency
General descriptor (warm, cool, coldwater)	State fish and game agencies
Sport fish species present	State fish and game agencies
Stocking species stage of development frequency	Stocking agency
Habitat	
stream permanence	U. S. Geological Survey
stream order	U. S. Geological Survey
elevation	Reach File
gradient	Reach File
substrate	STORET: sediment, particle size class (80250-80256)[a]
width	STORET: stream width (00004)
depth	STORET: depth of stream, mean (00064)
velocity	STORET: velocity of discharge (81380)
flow annual maximum-minimum average Jan-Mar, Apr-Jun, July-Sept, Oct-Dec	STORET: flow, stream (00061)
pool-riffle ratio	State fish and game agencies
temperature annual maximum-minimum duration ≤ 4°C duration ≥ 22°C	STORET: temperature, °C (00010)
total dissolved solids	STORET: solids, dissolved (70301)
turbidity	STORET: turbidity (00070)
alkalinity	STORET: alkalinity, total (00410)
pH	STORET: pH (standard units) (00400)
dissolved oxygen	STORET: DO, saturation percent (00301)

Continued

Table 6 (Concluded).

Descriptor	Source of information
macroinvertebrates	
number of species	STORET: number of species, macroinvertebrates (61458)
Shannon-Weaver diversity index	STORET: diversity index, Shannon-Weaver (61453)
standing crop	State fish and game agencies
Seasonally present species	State fish and game agencies
Pollutant causing consumption limitation	State water pollution control agencies
Wetlands	USFWS — National Wetlands Inventory, individual states
length of reach bordered	
area of wetlands	
Aquatic threatened and endangered species (nonfish)	USFWS — Office of Endangered Species
Aquatic species of special concern (nonfish)	Individual States
Other considerations	
Federal	
Wild and Scenic River length	Department of the Interior— Heritage Conservation and Recreation Service
Important Resource Problem Zone	U. S. Fish and Wildlife Service
species of concern	
lengths of reach covered	
National Fish and Wildlife Refuge	U. S. Fish and Wildlife Service
name	
length	
State	
Scenic River[b]	Individual States

---

[a] STORET reference number.

[b] Approximately one-half of the States have systems analogous to the National Wild and Scenic River System.

The sport fish species which inhabit the river reach are listed because they are the key element in the evaluative portion of the classification system. The dominant fish species used in the evaluation of the reach will be indicated in the printout for the evaluative section. The stocking of hatchery fish is used as part of an evaluative criterion, therefore this information is included in the descriptive section. The following information is included if the river reach is stocked or if stocked fish are caught from the reach: species of fish stocked, stage of development (fingerlings, fry, subcatchables, or catchables), and frequency of stocking. Such information, obtained from the stocking agency, indicates the effort of the stocking agency in maintaining the level of the fishery.

A variety of factors have been included under "habitat." These factors are important determinates of habitat and hence the biotic community. Many of the data are stored in and available from STORET.

The first consideration under the heading "habitat" is stream permanence. Pennak (1971, 1978), Rabe and Savage (1977), Cowardin et al. (1979), and Terrell et al. (1980) all include this factor in their classification schemes. Stream permanence is of significance especially in the arid west where some streams are dry during part or most of the year. The degree of permanence will affect the establishment of a resident fishery and can affect a migratory fishery.

Stream order is included because it is widely used and understood by both biologists and nonbiologists. Stream order has also been correlated with the number and diversity of fish species (Kuehne 1962, 1966; Harrel et al. 1967; Platts 1979a) and with the community structure of benthic macroinvertebrates (Harrel and Dorris 1968). Cummins (1975) found a variety of physical and biological characteristics associated with stream order such as primary production and the importance of terrestrial organic input. Several other classification systems incorporate stream order (Carleton et al. 1976; Rabe and Savage 1977; Warren 1979). In addition, Prosser (1978) lists stream order as data needed to manage fisheries. Vannote et al. (1980) in the "River Continuum Concept" related stream order to the ratio between gross primary productivity and community respiration (the P/R ratio). The relative dominance (as biomass) of the general macroinvertebrate functional groups--shredders, collectors, scrapers (grazers), and predators (Merritt and Cummins 1978)--is also expected to change as stream order increases.

Elevation will give the user further information on a physical description of the reach. When elevation, longitude, and latitude are given (with some basic knowledge of ecology) one can often make some generalizations about the reach. Although the temperatures associated with elevation, rather than elevation per se, may be the limiting factor, elevation is related to floral and faunal distribution. Elevation will be obtained directly from the Reach File.

Gradient, the degree of deviation from the horizontal, can be a limiting factor for fish species. It also indicates other factors such as stream velocity and substrate. Several existing classification systems incorporate gradient (Platts 1974; Rabe and Savage 1977; Terrell et al. 1980; USDA Forest Service n.d.). Prosser (1978) suggests gradient as important data in the management of fisheries. This information will be calculated by the Reach File using the elevation of the upstream and downstream boundaries of the reach and the reach length.

Substrate influences both the fish and invertebrate populations and has been used in a number of classification systems (Ricker 1934; Van Deusen 1953; Stream Classification Committee 1965; Rabe and Savage 1977; Cowardin et al. 1979; Warren 1979). Allan (1975) states that substrate appears to be one of the most basic aspects of the stream habitat. Cummins (1962) indicates that the relationship between benthic invertebrate distribution and the nature of the substrate can be direct or indirect; the indirect relationship is often due to the food material distribution which itself is dependent on substrate. When the stores are larger, indicating a more heterogeneous substratum, generally the invertebrate fauna is more diverse (Hynes 1970). Rabeni and Minshall (1977) found substratum correlated with the amount of colonization of benthic insects. Substrate is an important factor in the use of a reach for fish reproduction. Platts et al. (1979) found that spawning chinook salmon (Oncorhyncus tshawytscha) selected sediment having a geometric mean particle size mainly in the range 7-20 mm, regardless of stream selected.

The substrate data are to be obtained from STORET and include gravel (2 mm and larger), very coarse, coarse, medium, fine, and very fine sand, and silt-clay (0.0625 mm and smaller). These data are incomplete and it is suggested that the classes pebble, cobble, and boulder be added and silt and clay be divided into two separate classes as in Cummins (1962). Bedrock and organic content of the substrate should also be included as categories.

Width and depth are parameters which are easily obtained and describe the stream. Stream width is significantly related to trout biomass (Binns 1978). Other classification systems incorporating stream width and depth include Ricker (1934), Van Deusen (1953), Pennak (1971), and Platts (1974). USDA Forest Service (n.d.) includes a width-depth ratio in their system.

Velocity is an important parameter in determining the distribution of fish and other aquatic organisms. Rate of flow directly affects organisms and is interrelated with a variety of other factors such as substrate, bedload, suspended sediments, sinuosity, aquatic vegetation, temperature, and oxygen content. Velocity is routinely measured and reported and will be obtained from STORET. Stalnaker and Arnette (1976) state that velocity is a significant factor in both habitat selection and the spatial relationship of fish. Larger fish of a given species generally are found in the swifter waters because smaller individuals cannot maintain position. Sams and Pearson (1963, cited by Stalnaker and Arnette 1976) consider current velocity the most important factor in the spawning of anadromous salmonids. Stalnaker and Arnette (1976) include a table of the reported fish spawning depth-velocity criteria. Velocity is also important to the distribution of aquatic invertebrates. Some invertebrates have certain velocity requirements for respiration or feeding (e.g., species of Plecoptera [stoneflies], *Simulium* [black flies] larvae, trichopteran [caddisflies] species which construct silken nets). Scott (1958) concluded that velocity was the most important parameter in determining the distribution pattern of trichopteran larvae. Depth-velocity criteria for aquatic insects are listed by Stalnaker and Arnette (1976). Hynes (1970) concluded that "current speed is a factor of major importance in running water, and that it controls the occurrence and abundance of [benthic invertebrate] species and hence the whole structure of the animal community".

Flow (discharge) is a parameter vital to the well-being of aquatic organisms and their habitat (Tennant 1975). Binns (1978) found that late summer streamflows and seasonal streamflow variation are significantly related to trout biomass. Flow was also recommended as data needed to manage fisheries (Prosser 1978). Average flows will be given for the periods April-June, July-September, October-December, and January-March. Low and peak flows will also be given, when available. As a guideline for interpretation of these data, where available, the documented instream flow requirement will be given. See Prewitt and Carlson (1977) and Wesche and Rechard (1980) for discussion and analysis of various instream flow methodologies used to determine minimum flow requirements.

A pool-riffle ratio gives an indication of the suitability of the habitat for fish species. Although pools are important as nesting areas and cover for fish, food production in the form of benthic macroinvertebrates is often greatest in the riffle areas (Usinger 1974). For example, Rabeni and Minshall (1977) found 31 percent more aquatic benthic insects in the riffles than in the pools. Hynes (1970) states that the macroinvertebrate fauna of clean stony runs is generally higher in species richness than that of silty reaches and pools. There are circumstances, of course, in which these generalities do not hold. However, to produce good fish populations there must be a balance between the two habitats because riffles tend to produce food and pools produce cover for fish. Duff and Cooper (1976) state that generally the optimum stream is equally divided (50-50) in surface area between pools and riffles. These data will be obtained from the State fish and game departments.

Temperature is included as a descriptor because it is an important factor limiting the distribution of species both geographically and within a stream. Different species have different temperature ranges within which they can survive. For example, pike (*Esox lucius*) survive to about 29°C while brook trout cannot survive in temperatures above 25.3°C (Hynes 1970). These are the temperatures at which the fish can survive; however, at lower temperatures they most likely are limited in other activities such as feeding or reproduction. Water temperature can affect growth, larval and egg development, feeding, swimming endurance, and reproduction. If the temperature is inadequate for breeding, this information may lead to a stocking program. The information on temperature regime is particularly important for those reaches below dams where the reservoir strata of water release (i.e., from epi-, meta-, or hypolimnion) will affect temperatures downstream. Temperatures to be given are annual maximum-minimum, duration of temperatures ≤4°C, and duration of temperatures ≥22°C.

Total dissolved solids, turbidity, and alkalinity are included because they are important and often measured water chemistry parameters. Turbidity can be an important limiting factor (Odum 1971); it reduces light penetration and will affect photosynthesis of aquatic plants. Turbidity data should be given both for low and high discharge periods. In the Firehole River, Wyoming, there was a correlation between the relative density of riffle insects and the alkalinity of the water (Armitage 1958). The correlation between the number of Trichoptera and alkalinity was positive, but the correlation of Ephemeroptera with alkalinity was negative.

Measurements of pH have been included for several reasons; it is routinely and easily measured, hence data generally are available. Also pH influences the toxicity of various pollutants (Mount 1966; Stumm and Morgan 1970; Cairns et al. 1971). There is a concern in the United States and other countries about the acidification of waters; by including pH as a descriptor changes in the pH of reaches will become apparent over time.

Dissolved oxygen measurements (as percentage saturation) will be included when data are available. Oxygen in unpolluted waters rarely falls to very low levels except under extended continuous ice-cover or excessive input of leaves in the autumn into pools of an almost dry stream (Hynes 1970). Although oxygen content is generally near or above saturation in small turbulent streams, it is important as a factor in polluted waters where it may be limiting (Hynes 1970). Low dissolved oxygen measurements may indicate an organic pollution problem. Because oxygen levels may vary seasonally, diurnally and with depth, they must be interpreted with care. The yearly maximum and minimum will be given because low dissolved oxygen values are critical.

The number of species of macroinvertebrates (a component of diversity) will indicate stress because pollution, a rigorous physical environment, and other stresses will tend to decrease the numbers of species (Odum 1971). This information will be most useful to compare streams which physically are very similar, and for individual river reaches over time.

A macroinvertebrate diversity index (Shannon-Weaver) has also been included to indicate environmental stress. Generally, areas with "rigorous environmental conditions" have a lower diversity (Connell and Orias 1964). Care must be taken when interpreting these data because sampling methods, area sampled, time of year of sampling, and taxonomic level of identification have been found to affect the value of the index (Hughes 1975). As noted previously, streams from widely differing geographical areas should not be compared using only this index. Where available, the standing crop of macroinvertebrates will be given. These data will be highly variable, probably will be averages of summer sampling, and should only be interpreted in very general terms.

Spawning or nursery habitat and fish contamination are two of the criteria used in the evaluative statement. Consequently, a list of seasonally present species which use the river reach as a spawning or nursery habitat will be included in the Statement. The pollutants which limit or prohibit consumption of fish, and the species of fish restricted by the pollution will also be listed.

For those river reaches bordered by wetlands, the length of the reach which is bordered and the area of the wetlands bordering the reach will be included. Wetlands (see glossary) are included because they are important habitats and they often provide habitat and food to the riverine organisms. Waterbodies such as backwater swamps and pools, which periodically are in contact with rivers, supply plankton to the rivers, are used as spawning areas by some fishes, and are nursery grounds for many others (Hynes 1970). Northern pike, for example, often use marshes as spawning habitat (Carlander 1969). Wetlands also provide habitat for a variety of nonfish species. These wetlands are often dependent on the adjacent river for a water supply. The U. S. Fish and Wildlife Service is conducting a national wetlands inventory from which pertinent information will be obtained. Information will also be obtained from States which have mapped wetlands.

Short (1981) found that users of the Stream Evaluation Maps produced by the U. S. Fish and Wildlife Service requested more specific information on endangered and threatened species such as which threatened and endangered species exist in the reach and whether or not the river reach is critical habitat. They also recommended consideration of both plant and animal species. These suggestions have been incorporated in the descriptor section of the Statement. Consequently, other aquatic threatened and endangered species whose critical habitat or present range includes the river reach, and other State aquatic species of special concern, also will be listed.

Under "other considerations", designations of the river reach such as Wild and Scenic Rivers or State scenic rivers are given. This information has been included because it immediately conveys certain information about the river. For example, the Wild and Scenic Rivers Act (Public Law 90-542) established three classes of rivers--wild, scenic, and recreational. The Act states,

> Wild rivers are those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted. These represent vestiges of primitive America. Scenic rivers are those rivers or sections of rivers that are free of impoundments with shorelines or watersheds still largely primitive and shorelines largely undeveloped but accessible in places by roads. Recreational rivers are those rivers or sections of rivers that are readily accessible by road or railroad that may have some development along their shorelines, and that may have undergone some impoundment or diversion in the past.

These rivers are so designated because they,

> ...with their immediate environments possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or similar values, should be preserved in free-flowing condition, and that they and their immediate environments should be protected for the benefit and enjoyment of present and future generations.

If a river has received a designation as a Wild and Scenic River it has met the above criteria. The other designations to be considered also have specific criteria which must be met.

REFERENCES

Allan, J. D. The distributional ecology and diversity of benthic insects in Cement Creek, Colorado. Ecology 56:1050-1053; 1975.

Anderson, J. R.; Hardy, E. E.; Roach, J. T.; Witmer, R. E. A land use and land cover classification system for use with remote sensor data. U. S. Geological Survey Professional Paper 964; 1976; 28 p.

Anonymous. Michigan stream classification; 1967 system. Michigan Department of Natural Resources; 1967; 9 p.

Armitage, K. B. Ecology of the riffle insects of the Firehole River, Wyoming. Ecology 39:571-580; 1958.

Arnette, J. L. Nomenclature for instream assessments. C. B. Stalnaker and J. L. Arnette, eds. Methodologies for the determination of stream resource flow requirements: an assessment. Logan, UT: U. S. Fish and Wildlife Service; 1976; 9-15.

Bailey, R. E.; Maughan, O. E.; Whaley, R. A. Stream classification system for West Virginia. Proceedings of a symposium on trout habitat research and management. Boone, NC: Appalachian Consortium Press; 1974: 78-86.

Binns, N. A. Evaluation of habitat quality in Wyoming trout streams. A. Marmelstein, ed. Proceedings of the national symposium, classification, inventory, and analysis of fish and wildlife habitat. Washington, DC: U. S. Fish and Wildlife Service, Office of Biological Services, FWS/OBS-78/76; 1978: 221-242.

Bureau of Outdoor Recreation. Wild and Scenic Rivers, Outdoor Recreation Action. No. 43; 1977.

Cairns, J., Jr.; Timothy, K. B.; Burton, D. T.; Dickson, K. C.; Sparks, R. E.; Waller, W. T. The effects of pH, solubility, and temperature upon the acute toxicity of zinc to the bluegill sunfish (*Lepomis macrochirus* Raf.) Trans. Kansas Acad. Sci. 74:81-92; 1971.

Carlander, K. D. Handbook of freshwater fishery biology, vol. 1. Ames, IA: Iowa State University Press; 1969.

Carleton, O.; Cook, R. A.; Driscoll, R. S.; Gallaher, W. B.; Hagemeier, J. L.; Schubert, G. H. Modified ECOCLASS - a method for classifying ecosystems. USDA Forest Service, Rocky Mountain and Southwestern Regions; 1976 draft; 117 p.

Connell, J. H.; Orias, E. The ecological regulation of species diversity. Am. Nat. 98:399-414; 1964.

Cowardin, L. M.; Carter, V.; Golet, F. C.; LaRue, E. T. Classification of wetlands and deepwater habitats of the United States. Washington, DC: U. S. Fish and Wildlife Service, Office of Biological Services, FWS/OBS-79/31; 1979; 103 p.

Cummins, K. W. An evaluation of some techniques for the collection and analysis of benthic samples with special emphasis on lotic waters. Am. Midl. Nat. 67:477-504; 1962.

Cummins, K. W. The ecology of running waters; theory and practice. Great Lakes Commission; International Research Group on Great Lakes Pollution from Land Use Activities. Proceedings of the Sandusky River Symposium. Tiffen, OH; 1975: 277-293.

Duff, D. A.; Cooper, J. L. Techniques for conducting stream habitat survey on national resource land. U. S. Department of the Interior, Bureau of Land Management, Technical Note 283; 1976; 72 p.

Ehrenfeld, D. W. The conservation of non-resources. Am. Sci. 64:648-656; 1976.

Environmental Protection Agency. Water monitoring strategy. Washington, DC: Monitoring and Data Support Division; 1980 draft; 21 p.

Georgia Department of Natural Resources. Water quality monitoring data for Georgia streams 1976. Atlanta, GA: Environmental Protection Division, 1977; 339 p.

Greentree, W. J.; Aldrich, R. C. Evaluating stream trout habitat on large-scale aerial color photographs. Berkeley, CA: USDA Forest Service Res. Paper PSW-123, Pacific Southwest Forest and Range Exp. Stn.; 1976; 21 p.

Harrel, R. C. B.; Davis, J.; Dorris, T. C. Stream order and species diversity of fishes in an intermittent stream. Am. Midl. Nat. 78:428-436; 1967.

Harrel, R. C.; Dorris, T. C. Stream order, morphometry, physiochemical conditions and community structure of benthic macroinvertebrates in an intermittent stream system. Am. Midl. Nat. 80:220-251; 1968.

Hawkes, H. A. River zonation and classifications. B. A. Whitton, ed. River ecology: studies in ecology, vol. 2. Berkeley, CA: University of California Press; 1975: 312-375.

Heritage Conservation Recreation Service. Nationwide rivers inventory: a report on natural and free-flowing rivers in the northwestern United States. Washington, DC: U. S. Department of the Interior; 1980; 51 p.

Holder, D. R. Contribution of stocked fingerlings to the creel; final report, Project No. AFS-9, Evaluation of stocked fingerling striped bass. Atlanta, GA: Georgia Division of Natural Resources, Fish Division; 1974; 48 p.

Horton, R. E. Erosional development of streams and their drainage basins. Bull. Geol. Soc. Am. 56:275-370; 1945.

Hughes, B. D. The influence of factors other than pollution on the value of Shannon's diversity for benthic macroinvertebrates in streams. Water Res. 12:359-364; 1978.

Hynes, H. B. N. The ecology of running waters. Toronto: Univ. of Toronto Press; 1970.

Idaho Fish and Game Department. Idaho stream classification; 1968. (map)

Illies, J.; Botosaneanu, L. Problemès et mèthodes de la classification et de la zonation écologique des eaux courantes, considerées surtout du point de vue faunestique. Mitt. int. Ver. Limnol. 12:1-57; 1963.

Knight, A. W.; Gaufin, A. R. Stream type selection and associations of stoneflies (Plecoptera) in a Colorado River drainage system. J. Kan. Ent. Soc. 40:347-352; 1967.

Kuehne, R. A. A classification of streams illustrated by fish distribution in an eastern Kentucky creek. Ecology 43:608-614; 1962.

Kuehne, R. A. Depauperate fish faunas in sinkings near Mammoth Cave, Kentucky. Copeia 2:306-311; 1966.

Leopold, L. Quantitative comparisons of some aesthetic factors among rivers. U. S. Geological Survey Circular 620; 1969; 16 p.

Leopold, L. B.; Wolmen, M. G.; Miller, J. P. Fluvial processes in geomorphology. San Francisco, CA: W. H. Freeman and Co.; 1964.

Merritt, R. W.; Cummins, K. W., editors. An introduction to aquatic insects of North America. Dubuque, IA: Kendall/Hunt Publ. Co.; 1978.

Mount, D. I. The effect of total hardness and pH on acute toxicity of zinc to fish. Air Water Pollut. Int. J. 10:49-56; 1966.

National Commission on Water Quality. Staff draft report: water quality analysis and environmental impact assessment of Public Law 92-500, technical volume. Washington, DC; 1976; 27 p.

New York State Department of Environmental Conservation. New York State 1979-80 small game hunting/fishing. New York; 1979; 96 p.

Odum, E. P. Fundamentals of ecology. Philadelphia, PA: W. B. Saunder Company; 1971.

Pennak, R. W. Collegiate dictionary of zoology. New York: The Ronald Press Company; 1964.

Pennak, R. W. Toward a classification of lotic habitats. Hydrobiologia 38:321-334; 1971.

Pennak, R. W. The dilemma of stream classification. A. Marmelstein, ed. Proceedings of the national symposium, classification, inventory, and analysis of fish and wildlife habitat. Washington, DC: U. S. Fish and Wildlife Service, Office of Biological Services, FWS/OBS-78/76; 1978: 59-66.

Pfankuch, D. J. Stream reach inventory and channel stability evaluation: a watershed management procedure. Missoula, MT: USDA Forest Service, Northern Region; 1975; 26 p.

Platts, W. S. 1974. Geomorphic and aquatic conditions influencing salmonids and stream classification with application to ecosystem classification. Boise, ID: USDA Forest Service Intermt. For. and Range Exp. Stn.; 1974; 200 p.

Platts, W. S. Including the fishery system in land planning. Ogden, UT: USDA Forest Service Intermt. For. and Range Exp. Stn.; 1979a; 76 p.

Platts, W. S. Relationships among stream order, fish populations, and aquatic geomorphology in an Idaho river drainage. Fisheries 4(2):5-9; 1979b.

Platts, W. S. A plea for fishery habitat classification. Fisheries 5(1):2-6; 1980.

Platts, W. S.; Shirazi, M. A.; Lewis, D. H. Sediment particle sizes used by salmon for spawning with methods for evaluation. Corvallis, OR: Environmental Protection Agency, Environmental Research Laboratory, EPA 600/3-79-043; 1979; 33 p.

Prewitt, C. G.; Carlson, C. A. Evaluation of four instream flow methodologies used on the Yampa and White Rivers, Colorado. CO: Bureau of Land Management, Biological Sciences Series #2; 1977; 65 p.

Prosser, N. S. Habitat data needs for managing fishes (Appendix A). L. R. Jahn. Habitat data needs for managing wildlife. A. Marmelstein, ed. Proceedings of the national symposium, classification, inventory, and analysis of fish and wildlife habitat. Washington, DC: U. S. Fish and Wildlife Service; Office of Biological Services, FWS/OBS-78/76; 1978: 10-12.

Rabe, F. W.; Savage, N. L. Aquatic natural areas in Idaho. Moscow, ID: Idaho Water Resources Research Institute, University of Idaho, 1977; 105 p.

Rabeni, C. F.; Minshall, G. W. Factors affecting microdistribution of stream benthic insects. Oikos 29:33-43; 1977.

Ricker, W. E. An ecological classification of certain Ontario streams. Univ. Toro. Stud. Biol. Ser.; Ont. Fish Res. Lab; Publ. No. 49; 1934; 114 p.

Sams, R. E.; Pearson, L. S. A procedure for determining spawning flows for fisheries. U. S. Fish and Wildlife Service Mimeo Rep.; 1963; 12 p.

Savage, N. L.; Rabe, F. W. Stream types in Idaho: an approach to classification of streams in natural areas. Biol. Conserv 15:301-315; 1979.

Schumm, S. A. A tentative classification of alluvial river channels. U. S. Geological Survey Circular 477; 1963; 10 p.

Scott, D. L. Ecological studies on Trichoptera of the River Dean, Cheshire. Arch. Hydrobiol. 54:340-392; 1958.

Short, C. Evaluation of the Stream Evaluation Maps. Fort Collins, CO: U. S Fish and Wildlife Service, Western Energy and Land Use Team; 1981; 25 p.

Stalnaker, C. B.; Arnette, J. L. Methodologies for determining instream flows for fish and other aquatic life. C. B. Stalnaker and J. L. Arnette, eds. Methodologies for the determination of stream resource flow requirements: an assessment. Logan, UT: U. S. Fish and Wildlife Service; 1976: 89-138.

Strahler, A. N. Quantitative analysis of watershed geomorphology. Trans. Am. Geophys. Union 38:913-920; 1957.

Stream Classification Committee. A classification of Montana fishing streams; 1965. (map)

Stumm, W.; Morgan, J. J. Aquatic chemistry; an introduction emphasizing chemical equilibria in natural waters. New York: John Wiley & Sons, Inc.; 1970.

Tennant, D. L. Instream flow regimes for fish, wildlife, and recreation and related environmental resources. Billings, MT: U. S. Fish and Wildlife Service; 1975; 30 p.

Terrell, T. T.; Carter, V.; Platts, W. S.; Janes, E. B.; Theurer, F. D.; Cuplin, P. An aquatic classification proposed for use with the National Site Classification System. 5-way Interagency Policy Committee (U. S. Fish and Wildlife Service, U. S. Geological Survey, U. S. Forest Service, Bureau of Land Management, Soil Conservation Service); 1980 draft; 173 p.

USDA Forest Service. Proposed classification and management of the WATER SYSTEM CORRIDOR. USDA Forest Service, Rocky Mountain Region; n.d.; 23 p.

U. S. Fish and Wildlife Service. 1978 Stream Evaluation Map, State of Colorado; 1978a. (map)

U. S. Fish and Wildlife Service. 1978 Stream Evaluation Map, State of Idaho; 1978b. (map)

U. S. Fish and Wildlife Service. 1978 Stream Evaluation Map, State of Nebraska; 1978c. (map)

U. S. Fish and Wildlife Service. 1978 Stream Evaluation Map, State of Nevada; 1978d. (map)

U. S. Fish and Wildlife Service. 1978 Stream Evaluation Map, State of North Dakota; 1978e. (map)

U. S. Fish and Wildlife Service. 1978 Stream Evaluation Map, State of Oklahoma; 1978f. (map)

U. S. Fish and Wildlife Service. 1978 Stream Evaluation Map, State of South Dakota; 1978g. (map)

U. S. Fish and Wildlife Service. 1978 Stream Evaluation Map, State of Texas; 1978h. (map)

U. S. Fish and Wildlife Service. 1978 Stream Evaluation Map, State of Utah; 1978i. (map)

U. S. Fish and Wildlife Service. 1978 Stream Evaluation Map, State of Wyoming; 1978j. (map)

U. S. Fish and Wildlife Service. 1979 Stream and Lake Evaluation Map, State of Colorado; 1979. (map)

U. S. Fish and Wildlife Service. Endangered Species Technical Bulletin, vol. V, no. 3. Washington, DC: Endangered Species Program; 1980a.

U. S. Fish and Wildlife Service. Status of fisheries and aquatic habitat, River Reach File Phase I, Final Report. Washington, DC: Biological Services Program, Report to Environmental Protection Agency, Monitoring and Data Support Division; 1980b; 49 p.

U. S. Fish and Wildlife Service. 1980 Stream Evaluation Map, State of Montana; 1980c. (map)

U. S. Water Resources Council. Streams of national significance for fish and wildlife. Second national assessment of water and related land resources. Washington, DC; 1977. (map)

U. S. Water Resources Council. Water resources aggregated subregions. Washington, DC; 1979.

Usinger, R. L. Introduction to aquatic entomology. R. L. Usinger, ed. Aquatic Insects of California. Berkeley, CA: University of California Press; 1974: 3-49.

Van Deusen, R. D. A simplified technique for classifying streams useful in fishery and related resource management. Prog. Fish-Cult. 15:14-19; 1953.

Vannote, R. L.; Minshall, G. W.; Cummins, K. W.; Sedell, J. R.; Cushing, C. E. The river continuum concept. Can. J. Fish. Aquat. Sci. 37:130-137; 1980.

Warren, C. E. Toward classification and rationale for watershed management and stream protection. Corvallis, OR: Environmental Protection Agency, Environmental Research Laboratory, EPA 600/3-79-059; 1979; 142 p.

Wesche, T. A.; Rechard, P. A. A summary of instream flow methods for fisheries and related research needs. USDA Forest Service, Eisenhower Consortium Bull. 9; 1980; 122 p.

Wyoming Game and Fish Commission. Wyoming stream fishery classification; 1977. (map)

Zhukinskiy, V. N.; Oksiyuk, O. P.; Tseyev, Ya. Ya.; Georgiyevskiy, V. B. A draft unified system for the description of continental bodies of water and water courses and its application to water quality analysis. Hydrobiological J. 12(6):93-105; 1976.

GLOSSARY

catchables - Fish whose length meets or exceeds the State minimum size requirement.

conservation of the species - To use and the use of all methods and procedures which are necessary to bring any endangered or threatened species to the point at which the measures provided pursuant to the Act are no longer necessary (U. S. Fish and Wildlife Service 1980a).

critical habitat - (1) the specific areas within the geographical area occupied by a species at the time it is listed in accordance with the Endangered Species Act, on which are found those physical or biological features, (i) essential to the conservation of the species and (ii) which may require special management considerations or protection, and (2) specific areas outside the geographical area occupied by a species at the time it is listed upon a determination by the Director of the Office of Endangered Species that such areas are essential for the conservation of the species (U. S. Fish and Wildlife Service 1980a).

fingerlings - A length designation for immature fish; from 1 inch long, or disappearance of yolk sac, to whatever size is attained at the end of the first year's growth (Pennak 1964).

frequently stocked population - A population which is stocked on an annual basis or more often.

fry - Immature fish less than 1 inch long or retaining the yolk sac.

infrequently stocked population - A population which is stocked less often than annually.

relative productivity - A comparison of the actual produc[illegible] of the dominant sport fish in the reach to a regional standard for that species.

river reach - That portion of a river or stream which extends downstream from the confluence of two rivers or streams (or from the uppermost end of a river or stream) to the next encountered confluence; any subdivision of such a portion is also considered a reach. Reaches end at the beginning of tidal influences and do not include reservoirs.

self-sustaining population - A population which will maintain a sport fishery with basic enforcement of fishing regulations and habitat protection.

sport fish - A fish species for which a State has set a legal bag limit for a conventional fishing license.

subcatchables - Fish whose size is less than the minimum required by the State but greater than 1 year's growth.

wetlands - Most wetlands have one or more of the following attributes: (1) at least periodically the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year (Cowardin et al. 1979).

APPENDIX A

SUMMARY OF COMMENTS

A copy of the draft report was sent to the fish and game department and the water pollution control agency of each State. Thirty-eight State responses were received, twenty-seven of which were from fish and game departments. (See a list of respondents at the end of this Appendix.) In addition, written comments were received from 11 individuals in EPA, FWS, Council on Environmental Quality, the Ohio River Valley Water Sanitation Commission, and from three consultants. A wide variety of comments were received; some agreed or disagreed with the overall methodology or offered no substantial criticism while others offered specific criticisms of various components. Often the opinion of one respondent was directly opposed to that of another. A summary of these comments follows.

GENERAL COMMENTS

Sixteen respondents stated they were in general agreement with the concept or methodology presented in the draft. Three others commented the system would be beneficial and is a system for which they would have a use. Favorable comments included "the standardized and easily-accessible information which the system proposes to provide for each river reach could be a valuable aid to planning, especially for federal agencies," "we recognize the need for developing 'A Standardized Method for Classifying the Status and Type of Fisheries' as proposed," and "it will be beneficial and will accomplish its intended purpose." Two States indicated that they would have no use for it. One respondent said a nationwide system may be undesirable. It was stated that a logical justification for the need for a nationwide stream classification system should be included.

Four States emphasized that it was the State's prerogative to manage the fishery and thought it was inappropriate for the Federal Government to interfere without the State's consent. Two States also believed that the management objectives of the States were not taken into account. Four States questioned the desirability of meeting the objective of minimizing State-to-State variability.

One comment was made that a greater emphasis should be placed on the particular species making up the fishery. It was further suggested that rather than "developing an overly simplistic and rigid point system, the data base should provide key information with which the public agencies and public at large can see the tradeoffs in any future planning or management decision." One respondent thought that more emphasis should be placed on the descriptive statement because the evaluative section has a degree of uncertainty. Another respondent stated that the emphasis should be on water quality and fish forage production for the benefit of downstream fish. The opinion of one respondent was that the importance of the stream reach as a sport fishery as evaluated by this system was based on subjective professional opinion.

Two respondents stated the system does not accurately classify the status and type of fishery; however, one respondent thought that it does seem valuable as an index for evaluating the fish habitat. Another commenter remarked that the system is feasible for qualitatively classifying types of fisheries. The question of how the system will be used was asked by two respondents. Three respondents stated that sport fish are not necessarily more sensitive to pollutants than nonsport fish species.

DATA AVAILABILITY

Seven respondents questioned the availability of data. However, a State respondent commented that the system "would not require an excessive number of man-days to conduct." Another comment was that "systems containing complete information on all trophic levels were deemed unusable" and cautioned against "making categorizations on inadequate data which might not withstand formidable opposition." Three inquiries were made as to who will be responsible for data collection and interpretation. Two commenters suggested that other sources of data be included.

CRITERIA

One respondent commented that the choice of evaluation factors in disregarding many descriptors seemed arbitrary. Three respondents believed that some indirect nonbiological factors which are components of the value of the fishery such as accessibility should be taken into account. Other nonbiological factors suggested for incorporation include aesthetics, fishing use, unusual ecosystems nearby, proximity to urban areas, and degree of disturbance. Two requests were that there be some indication of quality of fish (i.e., size, species) or fishing quality. Three suggestions were that species be scored differently based on human preference. According to three respondents some form of productivity should also be included. A comment was made that some evaluator of the habitat in addition to the sport fish would provide a more reliable classification. Also, it was expressed that a stream contributing forage fish to a lentic environment should rate high even without its own sport fishery. Two recommendations were made that the system give points to a reach for having a number of sport fish species.

Biomass Ratio

Seventeen respondents expressed resistance to using the biomass ratio because they believed that lower production waters could and often would receive a higher score than highly productive waters or the ratio was not indicative of the quality of the fishery. Three respondents indicated the ratio would be of some value provided data are available. Whether the nonsport fish are competing with the sport fish or if they are providing forage food was considered more important by two respondents than a biomass ratio.

Sport Fish Categories

Conflicting recommendations for categorizing fish species were made. Three comments were in favor of combining self-sustaining native and introduced fish species, but another strongly advised combining these two categories only if the fish were stocked. It was also suggested by three respondents that introduced and native species be combined regardless. Two recommendations were made that self-sustaining populations not be differentiated from hatchery supported populations. Another suggestion was to score native species the highest whether a sport fish species or not.

Multiplier

It was noted that with the multipliers a stream reach with three species could score lower than a reach with only one and a reach with three native species scores no higher than a reach with only one.

Spawning or Nursery Habitat for Migratory Species

One respondent questioned weighing spawning and nursery habitat equally; it was believed that if spawning habitat was a more limiting factor it should score more. Three respondents advised that spawning habitat for resident species be included.

Migratory Route

Two comments were made that "migratory species" and "migratory routes" need clarification. One respondent noted that usually more than one migratory species will be present; consequently, the score differential would not be meaningful.

Commercial Harvesting

Three comments were received that commercial fishing is not necessarily biologically determined; it may be a function of legislative constraints or economics. It was also stated that commercial fishing may only be allowed in "poorer quality" streams with rough fish. Two suggestions were made that some concept of the size of the commercial fishery should be included.

One request was that additional points be given if more than one species is harvested.

Fish Contamination

A response was received that the contamination scoring should be more spread out. Two respondents commented that points should not be added for non-contamination. It was suggested that another category, "contamination present; consumption not limited" be included. Also, it was recommended that pollution be "ordered" by three levels of direct toxicity (chronic, sporadic fish kills, sport fish productivity limited by water quality). It was suggested that fish tissue organochlorine residue be compared to NAS/NAE (Bluebook) criteria to determine if the levels could threaten the well-being of the fish.

Threatened and Endangered Species

Three persons believed that threatened and endangered species were scored too low. According to one respondent, if more than one endangered species is present additional points should be given. Another comment made was that threatened and endangered species have little to do with the fishery value. Two requests were made to include State threatened and endangered species. It was suggested that threatened and endangered species be moved to special or unique considerations because they are a biological fact.

SCORING

Eight comments were made that the scoring scheme incorrectly rates certain fisheries and compromises the value of many valuable fisheries. Six respondents had strong concerns that a State's streams would not score as high as the State would deem acceptable. Furthermore, three commenters were concerned that a low score would encourage development and degradation of the stream or river. Three suggestions were made to omit scoring entirely, or at least extensively revise it. The scoring was seen by one commenter as ranking by economic and legal considerations. A suggestion was that a single criterion bring the reach near the highest ranking. Grouping scores into excellent, good, and so forth was also criticized. Three respondents thought that manipulation of the score should not be allowed, however, a suggestion that users be allowed to devise their own scoring scheme was also made. A suggestion was made that verbal descriptors be used to form an evaluation matrix of "outstanding" through "severely degraded," then each reach could be rated on each criterion and a numerical system developed from this.

According to one commenter the scoring system does not consider the potential of the fish population to improve. Three respondents stated it did not incorporate an idea of the quality of the fishery. It was noted that the scores are comparable only on a regional basis. Also, one respondent indicated that a regional normalization should be applied to the raw score. One person cautioned that while rerating a reach with more information was acceptable, adding criteria would require redoing all the reaches. Another commented that it is difficult to apply a system nationwide and obtain a valid rating for every water.

IMPROVEMENT POTENTIAL

Two respondents stated they generally agreed with the concept of a fishery potential. Another opinion stated was that the fishery potential is needed but is highly subjective. However, another State respondent stated that the fishery potential is inseparable from fishery management goals, and questioned the need for it. It was suggested that the primary limiting factors also be included. A comment was made that it is quite likely that some reaches could not be improved to equate with the highest ranking reach.

CONFIDENCE RATING

The confidence rating was highly approved of by the two respondents who commented on it.

DESCRIPTORS

One respondent indicated that the descriptors should automatically accompany the evaluative section. Descriptors also should be of neutral value, with the interpretation left up to the user. Another comment was that most of the descriptors have nothing to do with biological integrity. Also, the report should address how the system is to deal with variable parameters such as temperature and velocity.

The following were suggested as additional descriptors:

- bedrock and organic content in the substrate descriptor;
- navigability;
- period of ice-[illegible] and subsequent scouring;
- pH;
- effects of dams;
- duration of temperatures over 72°F (22°C);
- for Western States the range, township, and section;
- note if the reach is in a national forest or national park;
- channel alterations;
- rate and trend of sediment deposition;
- benthic data;
- stability or rehabilitation potential;
- quality and extent of floodplain development;

- recreational value;
- type of fishery (warmwater, coolwater, coldwater); and
- agricultural, municipal, or industrial threats to the stream reach.

STATE RESPONDENTS

Alabama Department of Conservation and Natural Resources
Fisheries Section
C. E. White, Assistant Chief

Alaska Department of Fish and Game
Ronald O. Skoog, Commissioner

California Department of Water Resources
Division of Planning
Douglas E. Owen, Chief

Colorado Division of Wildlife
Jack R. Grieb, Director
P. T. Barrows, Wildlife Manager
Dan Schrupp[3]

Delaware Department of Natural Resources and Environmental Control
Division of Fish and Wildlife
Roy W. Miller, Supervisor of Finfisheries

Florida Department of Environmental Regulation
Bureau of Water Analysis
G. J. Thabaraj, Ph.D., Chief

Florida Game and Fresh Water Fish Commission
Division of Fisheries
F. G. Banks, Director

Hawaii Department of Land and Natural Resources
Division of Fish and Game
Kenji Ego, Director

Idaho Department of Fish and Game
Jerry M. Conley, Director

Illinois Department of Conservation
Division of Fish and Wildlife Resources
Mike Conlin, Chief

Iowa Department of Environmental Quality
Planning Section
Ralph Turkle

Iowa Conservation Commission
Robert D. Fagerland, Acting Director

Kansas Fish and Game
Ken Brunson, Stream Investigation and Development Biologist

Maine Department of Inland Fisheries and Wildlife
Glenn H. Manuel, Commissioner

---

[3] Attended the technical review session.

Massachusetts Division of
Fisheries and Wildlife
Dave Halliwell, Project Leader:
Stream Survey and Inventory

Michigan Department of Natural
Resources
Fisheries Division
Thomas R. Doyle, Environmental
Protection Specialist

Michigan Department of Natural
Resources
Biology Section
Carey Johnson, Aquatic Biologist

Montana Department of Health and
Environmental Science
Water Quality Bureau
Steven L. Pilcher, Chief

Montana Department of Fish and
Game
Fletcher E. Neuby, Acting Director

New Hampshire Water Supply and
Pollution Control Commission
Permits and Surveillance
Paul L. Heirtzler, P.E., Director

New Jersey Department of
Environmental Conservation
Division of Water Resources
Robert Runyon, Chief

New Jersey Department of
Environmental Protection
Division of Fish. Game and Wildlife
Russell A. Cookingham, Director

New Mexico Environmental
Improvement Division
Water Pollution Control Section
Gerald Z. Jacobi, Ph.D.

New York Department of
Environmental Conservation
Division of Fish and Wildlife
Kenneth F. Wich, Director

North Carolina Wildlife Resources
Commission
Scott Van Horn, Fishery Biologist

North Dakota Game and Fish
Department
Fred Ryckman, Garrison Diversion
Unit Biologist

Oklahoma Department of Wildlife
Conservation
George B. Wint, Director

Oregon Department of Fish and Game
Environmental Management Section
Office of the Director
James B. Haas, Chief

Pennsylvania Department of
Environmental Resources
Bureau of Water Quality Management
Division of Water Quality
Edward R. Brezina, Chief

Pennsylvania Fish Commission
Ralph W. Abele, Executive Director

South Carolina Wildlife and Marine Resources Department
District VII
Dan Crochet, Biologist

Texas Department of Natural Resources
Water Resources
Municipal Waste Water and Water Use Section
Michael G. Dick

Texas Parks and Wildlife Department
Charles D. Travis, Executive Director

Utah Division of Wildlife Resources
Douglas F. Day, Director

West Virginia Department of Natural Resources
Division of Wildlife Resources
Robert L. Miles, Chief

Wisconsin Department of Natural Resources
Water Quality Evaluation Section
Joe Ball, Biological Coordinator

Wisconsin Department of Natural Resources
Inland Fisheries Section
David Ives, Chief

Wyoming Game and Fish Department
W. Donald Dexter, Assistant Director
Mike Stone[3]

OTHER RESPONDENTS

Council on Environmental Quality
Environmental Data and Monitoring
John Ficke, Senior Staff Member

Environmental Protection Agency
Monitoring and Data Support
Robert Horn[3]

Environmental Protection Agency
Region VIII
Loys Parrish[3], Aquatic Biologist

Environmental Protection Agency
Region VIII
Denis Nelson, Research and Development Representative

Environmental Protection Agency
S & A Division
Ecology Branch
L. B. Tebo, Jr., Chief

Environmental Protection Agency
Western Region Laboratory and Environmental Center
H. Ronald Preston, Chief Aquatic Biologist

Ohio River Valley Water Sanitation Commission
John L. Keyes, Senior Surveillance Specialist

Soil Conservation Service
Fred Theurer (with Instream Flow Group)[3]

Soil Conservation Service
David Chalk (with Rocky Mountain Forest and Range Experiment Station)[3]

U. S. Fish and Wildlife Service
Columbia National Fisheries and Research Laboratory
Christopher J. Schmitt[3]

U. S. Fish and Wildlife Service
Office of Biological Services--Portland, Oregon
Robert Cleary[3]

U. S. Fish and Wildlife Service
Western Energy and Land Use Team
Ken Burnham, Team Biometrician

U. S. Fish and Wildlife Service
Western Energy and Land Use Team
Lee Ischinger[3]

Consultant
Oregon State University
Department of Fisheries and Wildlife
Dr. Kenneth W. Cummins

Consultant
Arizona State University
Zoology Department
Dr. Stuart G. Fisher[3]

Consultant
University of Colorado
EPO Biology
Dr. Robert W. Pennak[3]

Consultant
University of Idaho
Department of Biological Sciences
Dr. Fred Rabe

APPENDIX B

ABSTRACTS OF PERTINENT STREAM CLASSIFICATION SYSTEMS[4]

Anderson et al. (1976). A land use and land cover classification system for use with remote sensor data.

A mapping of the United States was proposed using remote sensory data (i.e., aerial photographs) dividing the aquatic ecosystem into five categories: streams and canals, lakes, reservoir, bay and estuaries, and wetlands.

Anonymous (1967). Michigan stream classification, 1967 system.

Streams were divided into two major types, trout streams and warmwater streams. Within each of these were subtypes, mainstream and feeder streams. The quality of the streams was described as either top quality or second quality. Criteria used in the classification were fish species (trout or salmon versus warmwater species), fish population levels, and stream width. Also designated were streams or rivers with significant populations of anadromous trout or salmon and the degree of stream zone development.

Bailey et al. (1974). Stream classification system for West Virginia.

The classification system for West Virginia was based on four factors. The factors, in decreasing order of importance, were aesthetics, access, use, and productivity. Each factor was rated numerically from 1 to 5 then weighed according to its importance to the production of a coldwater fishery. In the categories use and access the highest rating was assigned to moderate fishing pressure and moderate accessibility, respectively. Productivity was based on nine parameters which were weighed (pH, water temperature, total alkalinity, invertebrate abundance, turbidity, total hardness, conductivity, phosphates, and nitrates). The highest score was assigned to those conditions optimal for coldwater fish. After each factor was rated and multiplied by its weighing factor, the scores were summed and the stream was classified between Class 5 coldwater fishery of multi-State importance) and Class 1 (stream unsuited for coldwater species).

---

[4] Citations are included with the references for the text.

Carleton et al. (1976). Modified ECOCLASS - a method for classifying ecosystems.

ECOCLASS was a method for a hierarchical classification of ecosystems (the authors did not advocate the aquatic system for immediate operational use). The part of the system that adddressed the lotic environment first divided streams by stream order. The next level used the following criteria: gradient, pool-riffle ratio, inflow-outflow, and floodplains. Other data to be collected included fish species composition and population levels, fish stocking, diversity index for invertebrates, fish yield, aquatic vegetation (kind and abundance), sediment, transport, stream discharge, flow duration, and temperature.

Cowardin et al. (1979). Classification of wetlands and deep-water habitats of the United States.

This classification system dealt with wetlands and deepwater habitats. The riverine system had four subsystems: tidal, lower perennial, upper perennial, and intermittent. These subsystems were divided into classes based on substrate material and flooding regimes. At the lowest level was the dominance type which was based on the dominant plant or animal forms.

Cummins (1975). The ecology of running waters; theory and practice.

Flowing waters were categorized into three groups based on stream orders; orders 1-3, orders 4-6, and orders 7-12. Each group had general characteristics associated with it. The characteristics considered were stream size, the relationship between heterotrophy and autotrophy, organic matter inputs of terrestrial origin, primary production, light regime, temperature regime, and sediments.

Greentree and Aldrich (1976). Evaluating stream trout habitat on large-scale aerial color photographs.

Large-scale aerial color photographs were used to evaluate trout habitat. Photos were used to determine instream and streambank conditions. On properly exposed color photographs (1:1584 scale) the interpreter could readily discern the form, shape, and color of instream and streambank features. Some conditions such as average size of stream bottom aggregates, depth of water, streambank heights, and heights of streambank vegetation were estimated using special measuring aids.

Horton (1945). Erosional development of streams and their drainage basins.

In this paper the concept of stream order was developed. Fingertip streams or unbranched tributaries were designated first order streams; second order streams were those which only received first order streams. Those streams receiving second or first and second order streams were third order streams, and so forth.

Idaho Fish and Game Department (1968). Idaho stream classification.

A stream classification system was designed to establish fishery values for stream sections within Idaho. Five classes of streams were established based on the following five factors: aesthetics, availability, use, productivity, and size. A Class 1 stream was a stream rated highest in three of the five categories or streams which had anadromous fish populations, endangered or unique species, or containing spawning areas vital to an important fishery. The lowest ranking streams, Class 4 streams, were rated very low in one or more factors. Unclassified streams were placed in Class 5.

Knight and Gaufin (1967). Stream type selection and associations of stoneflies (Plecoptera) in a Colorado river drainage basin.

A stream classification system for the Gunnison River drainage, Colorado was used based on the stonefly (Plecoptera) fauna. Five main divisions were found: temporary or snow flood streams, small stony streams (high--above 3,000 ft and low--below 3,000 ft), stony rivers, constant rivers, and sluggish rivers.

Leopold (1969). Quantitative comparison of some aesthetic factors among rivers.

A system was devised to quantitatively compare the aesthetics of rivers. The three types of factors considered were physical features, biologic features, and human interest factors. The philosophy underlying the system was that a landscape which is unique (i.e., different from others or uncommon) has more significance to society than a landscape which is common.

Pennak (1971). Toward a classification of lotic habitats.

A system was designed to classify lotic habitats which would be applicable on a worldwide basis. Using the reasoning that widely separated streams and rivers having very similar nonbiological features will usually have parallel and ecologically similar faunas, the system was based primarily on physical and chemical features. The 13 parameters used were width, flow (temporary or permanent), current speed, substrate, summer temperatures, winter temperatures, turbidity, total dissolved inorganic matter, total dissolved organic matter, water hardness, dissolved oxygen, rooted aquatics, and streamside vegetation. The system was intended to be used primarily for unpolluted streams and small to medium rivers. A distinction was also made between "normal" streams and rivers, for which this system was designed, and atypical and special lotic conditions.

Pennak (1978). The dilemma of stream classification.

The lotic classification system divided U.S. streams into two main groups: distinctive lotic habitats which have relatively homogeneous and constant features, and indistinctive habitats which are highly variable and hence defy practical classification. Seven types of distinctive habitats given were springbrooks, tundra brooks, mountain trout streams, sandy streams and rivers of the Great Plains, medium to large silted rivers, sewage pollution stretches, and irrigation ditches. The indistinctive lotic habitats include intermittent streams, desert streams, streams traversing agricultural lands, meadow brooks, canals, and others. It was suggested that the criteria listed in Pennak (1971) be used in classifying all indistinctive waters.

Pfankuch (1975). Stream reach inventory and channel stability evaluation.

The stated purpose of this system designed for the Forest Service was to "systemize measurements and evaluations of the resistive capacity of mountain stream channels to the detachment of bed and bank materials and to provide information about the capacity of streams to adjust and recover from potential changes in flow or increases in sediment production." The channel stability was evaluated using a variety of parameters such as bank stability, debris jam potential, and channel bottom information. The system was intended to allow measurement of management success.

Platts (1979a). Including the fishery system in land planning.

The streams in the study area in Idaho were found to be associated with one of four landtype associations at the geomorphic process level. The four types were glaciated, cryric, fluvial, and depositional. In the depositional landtype association, streams were further stratified by categorizing their association into two subgroups based on whether ice or water had deposited the soils within the association. The system related the geomorphic characteristics of landform to streams and fisheries.

Rabe and Savage (1977). Aquatic natural areas in Idaho.

Nonvariable physical characteristics were used to classify Idaho streams. Streams were first categorized into two groups using stream order: first through fourth order, and fifth order and higher. Five stream subtypes for orders 1-4 were based on observable differences in flow and gradient. The five subtypes were ephemeral streams, spring streams and three other types which were based on nature of flow, substrate, and gradient. These physical categories were differentiated partially on the basis of extensive biological collections, including macrophytes, invertebrates, and fish, which indicated different associations for each permanent stream type. Associations of plants and insects were found to correlate fairly well with stream type but not with other physical or chemical factors.

Ricker (1934). An ecological classification of certain Ontario streams.

Streams were classified into two main groups, creeks and rivers, based on volume of flow and width. Creeks were broken down into spring creeks and drainage creeks. Spring creeks had four subtypes based on substrate, discharge, and vegetation. Rivers were classified into trout streams and warm rivers. Further divisions were made on the basis of substrate, discharge, vegetation and other biota, and water hardness.

Schumm (1963). A tentative classification of alluvial river channels.

Streams were classified on the basis of sediment load. Nine subclasses were developed on the basis of channel stability (stable, eroding, depositing) and the dominant mode of sediment transport (suspended, bedload, mixed).

Strahler (1957). Quantitative analysis of watershed geomorphology.

This classification scheme was a modification of the system of stream order, developed by Horton (1945). The smallest fingertip tributaries were designated order one: where two first order streams join, a second order channel was formed. A third order stream was formed when two second order streams met, and so forth.

Streams Classification Committee (1965). A classification of Montana fishing streams.

Montana streams were evaluated on the basis of the value of the sport fishery. The streams were divided into five classes ranging from streams of national or statewide value (Class 1) to streams of restricted local value or streams not yet classified (Class 5). The factors considered were availability (degree of access), aesthetics, use, and productivity. The primary considerations in rating productivity included width, depth, pools and riffles, gradient, cover, shore vegetation, boulders, spawning areas, temperature, fertility, fishfoods, and abundance of desirable fishes.

Terrell et al. (1980). An aquatic classification proposed for use with the National Site Classification System.

The riverine system of the U.S. was divided into five categories: tidal, lower perennial, upper perrennial, intermittent, and ephemeral. They were defined on the basis of water permanence, gradient, water velocity, substrate, and the extent of floodplain development. At the lowest level of the classification system a variety of physical and chemical characteristics were involved.

USDA Forest Service (n.d.). Proposed classification and management of the Water System Corridor.

The aquatic zone was divided into three types of streams (A, B, C) and seven subtypes (1-7) based on hydrologic data (gradient, sinuosity ratio, width-depth ratio, dominant particle size, adjacent landform, degree of entrenchment, channel stability, and sediment supply). Each criterion was divided into ranges to which points were assigned. The summed score determined the stream type and subtype.

U. S. Fish and Wildlife Service (1978a-j). 1978 Stream Evaluation Maps.

The Stream Evaluation Maps developed for 10 western states evaluated the fishery habitat of permanent streams, their tributaries, and those streams protected by or proposed for protection under the Wild and Scenic Rivers Act. Those intermittent streams considered necessary for the sustenance of a highly valued fishery were also evaluated. Streams classified were placed in one of four classes; Class 1 - highest-valued fishery resource, Class II - high-priority fishery, Class III - substantial fishery, Class IV - limited fishery. The four criteria used to classify the streams were (1) occurrence of State or Federal endangered species; (2) occurrence of State or Federal Threatened species; (3) species of high interest to the State; and (4) habitat restoration, reclamation, or mitigation potential. Criterion 4 was only used in a few instances to upgrade or downgrade the overall habitat evaluations when the rating for criteria 1-3 was less than the highest possible. Highest-valued streams were those with a documented presence of a State or Federal endangered species, a documented present occurrence of a State or Federal threatened species, or a habitat maintaining an outstanding fish population of a species of high interest as defined by the State. A limited fishery resource had no endangered or threatened species and habitat that is not used or is sporadically or unpredictably used by species of high interest.

Usinger (1974). Introduction to Aquatic Entomology.

Streams of California were classified into eight groups based on biotic provinces. Each group was subdivided according to water permanence and water source.

U. S. Water Resources Council (1977). Streams of National Significance for Fish and Wildlife.

Riverine habitats of the United States were designated as being nationally significant for fish, wildlife, and endangered species. The factors used to classify the habitat as being nationally significant were (1) nationally important sport fishery; i.e., drawing a significant number of nonresident fishermen; (2) producing a significant anadromous fish resource; (3) producing a nationally important commercial inland fishery;

(4) supporting endangered or threatened species; (5) proposed Wild and Scenic Rivers; (6) enacted Wild and Scenic Rivers; and (7) riverine habitat within the National Wildlife Refuge System.

Van Deusen (1953). A simplified technique for classifying streams useful in fishery and related resource management.

A classification system designed for Maryland streams divided stream reaches into classes based on the characteristic fish species. The 11 classes were dace trickle, trout feeder, trout stream, sucker stream, bass feeder, bass stream, pickerel stream, bullhead stream, catfish stream, carp stream, and tidal stream. Other factors used to describe the class included stream width and depth, water temperature, water quality, bottom substrate, flow, volume, characteristic forms, and shade and cover.

Wyoming Game and Fish Commission (1977). Wyoming stream fishery classification.

The classification system of Wyoming streams was [illegible] to evaluate the value of the sport fishery. A Class 1 stream was one of national importance containing premium trout waters. Class 5 streams were lower production waters, often incapable of sustaining a fishery. To determine the appropriate class the streams were rated on aesthetics, availability, and productivity, multiplied by the weighting factors, 1, 2, and 4 respectively, and summed.

Zhukinskiy et al. (1976). A draft unified system for the description of continental bodies of water and water courses and its application to water quality analysis.

This classification system was proposed for universal use and included a wide variety and number of hydrologic, hydrochemical, and hydrobiological parameters. Hydrologic parameters consisted of river length, depth, discharge, velocity, transparency, and temperature. Hydrochemical characteristics included pH, color, percent oxygen saturation, mgN/liter, mgP/liter, organic carbon, and organic phosphorus. Hydrobiological information to be collected was number of species, total abundance, biomass, and primary production of the phytoplankton, phytomicrobenthos, and macrophytes. Also to be included were data on macrozoobenthos, bacteria, and a biotic index.

50272-101

REPORT DOCUMENTATION PAGE

1. REPORT NO. FWS/OBS-81/31

2.

3. Recipient's Accession No.

4. Title and Subtitle

REACH FILE PHASE II REPORT: A standardized method for classifying status and type of fisheries.

5. Report Date September 1981

6.

7. Author(s)

James E. Olson, Elizabeth A. Whippo, and Gerald C. Horak

8. Performing Organization Rept. No.

9. Performing Organization Name and Address

Enviro Control, Inc.
1520 E. Mulberry
Suite #250
Fort Collins, CO 80524

10. Project/Task/Work Unit No. Work Order No. 4

11. Contract(C) or Grant(G) No.

(C) 14-16-0009-79-106

(G)

12. Sponsoring Organization Name and Address

Western Energy and Land Use Team
U.S. Fish and Wildlife Service
Drake Creekside Building
2625 Redwing Road , Fort Collins, CO 80526

13. Type of Report & Period Covered

14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

The Reach File is a computerized catalog of the hydrological features of the United States. The file will organize and analyze water resources data and provide interpreted information concerning physical, chemical, and biological attributes of the cataloged river reaches. The project was initiated by the U.S. Environmental Protection Agency. This Phase II report was prepared under an interagency agreement between EPA and the U.S. Fish and Wildlife Service. The objective of Phase II was to design a standardized system for collecting information related to the type and quality of fisheries in the cataloged reaches. Fisheries type is determined by the species present, relative fish abundance, habitat categorization, and other parameters. Reproductive capabilities and capacity, diversity of the fishery, and degree of contamination reflect quality in the proposed system. The Reach File will improve the ability of Federal, State and local decision makers to retrieve water related information on a specific stream reach to assess existing and potential impacts or monitor the results of water pollution control or water resource development activities. Because it is national in scope and computerized, the file will be capable of performing extensive assessments of existing conditions, trends, and program impacts concerning aquatic resources.

17. Document Analysis a. Descriptors

Anadromous Fish Aquatic Environment Aquatic Life Aquatic Populations Classification Commercial Fishing Computer Programs Data Collections Data Processing Data Storage and Transmission Fisheries Fish Types Information Retrieval Rivers Sport Fish Stream Fisheries Water Resources

b. Identifiers/Open-Ended Terms

Threatened and Endangered Fish

c. COSATI Field/Group

18. Availability Statement

Release Unlimited

19. Security Class (This Report) Unclassified

20. Security Class (This Page) Unclassified

21. No. of Pages pages

22. Price

(See ANSI-Z39.18)

57

OPTIONAL FORM 272 (4-77)
(Formerly NTIS-35)
Department of Commerce

U. S. Department of the Interior

Fish and Wildlife Service

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

90%

50%

END

8 - 2 - 82